WCPE

WCPE
The World Conference on Physics Education

July 1-6, 2012

Bahçeşehir Üniversitesi, Istanbul / Turkey

www.wcpe2012.org

BOOK OF ABSTRACTS

WCPE 2012 Book of Abstracts

Edited by

M. Fatih Taşar

Gazi Üniversitesi, Ankara, Turkey

FOREWORD

Dear physics teachers, educators, and researchers,
Welcome to the very first World Conference of Physics Education.
On behalf of the Local Organization Committee I am very glad to introduce you the book of abstracts which is full of your research efforts that took many years to finalize. We are confident that this jump start will boost further enthusiasm to organize world conference in every four years from now on.
At this conference we have participants from all continents and from countries very far from Istanbul. We have 230 delegates, 68 doctoral students, 31 teachers participating in this conference from 49 countries. These are
Argentina, Armenia, Australia, Austria, Belgium, Bosnia and Herzegovina, Brazil, Canada, Colombia, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Latvia, Malaysia, Malta, Mauritius, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Turkey, UK, US, and *Uruguay.*
During the 6 days of the conference we will have 249 oral presentations, 27 workshops, 12 symposia, and around 100 poster presentations together with 5 keynote speeches.
On behalf of all participants I wish to thank the sponsors: IUPAP, ICPE, EPS, TÜBİTAK, GIREP, MPTL, Rentech, Vernier, APS, IOP, and Amasya Üniversitesi for their support. We are also grateful to AAPT, AsPEN, and LaPEN for their endorsements of the conference.
I wish much success and enjoyable sessions for the participants…

M. Fatih Taşar
The Main Organizer of WCPE 2012

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WCPE 2012 Conference Schedule

	JULY 1, 2012 SUNDAY	JULY 2, 2012 MONDAY	JULY 3, 2012 TUESDAY	JULY 4, 2012 WEDNESDAY	JULY 5, 2012 THURSDAY	JULY 6, 2012 FRIDAY
09:00-10:00		Keynote Speaker 2 *Bob Tinker*	Keynote Speaker 3 *Jon Ogborn*	Keynote Speaker 4 *Pornrat Wattanakasiwich*	Keynote Speaker 5 *Ed van den Berg*	**Session 11** 09:00-10:30
10:00-10:30	**REGISTRATIONS**	Coffee Break	Coffee Break	Coffee Break	Coffee Break	
10:30-12:00		Plenary Symposium 1 10:30-12:00	Plenary Symposium 2 10:30-12:00	**Session 7** 10:30-12:00	**Session 9** 10:30-12:00	Coffee Break Plenary Session 11:00-12:00
12:00-13:00		LUNCH BREAK	LUNCH BREAK	LUNCH BREAK	LUNCH BREAK	Closing Ceremony 12:00-12:30 LUNCH
13:00-14:00		**Session 2** 13:00-14:30	Poster Session - I 13:00-14:00	**Session 8** 13:00-14:30	Poster Session - II 13:00-14:00	
14:00-14:10	**Session 1** 14:00-15:30		Short Break		Short Break	
14:10-15:40		Short Break **Session 3** 14:40-16:10	**Session 5** 14:10-15:40	Short Break Conference Excursion* 14:40-16:30	**Session 10** 14:10-15:40	
15:40-16:10	Opening Ceremony 15:30-16:00		Coffee Break 15:40-16:00		Coffee Break 15:40-16:00	
16:10-17:40	Keynote Speaker 1 *Edward (Joe) Redish* 16:00-17:00	Coffee Break 16:10-16:30 **Session 4** 16:30-18:00	**Session 6** 16:00-17:30		**GIREP Assembly Meeting** 16:00-17:00	
17:40-19:00	Welcome Cocktail 17:00-19:00					
19:00-24:00					Conference Dinner* 19:00-23:30	

*** Not included in the conference registration fee and requires registration.**

LIST OF CONFERENCE TOPICS (STRANDS)

WCPE Main Topics:

1. ICT and Multi-Media in Physics Education
2. Teaching Physics Concepts
3. Learning Physics Concepts
4. Laboratory Activities in Physics Education
5. Primary School Physics
6. Secondary School Physics
7. University Physics
8. Initial Physics Teacher Education
9. Teacher Professional Development
10. Physics Curriculum
11. Motivational Strategies and Metacognition
12. History of Physics
13. Philosophy of Science
14. Socio-cultural Issues
15. Physics Teaching and Learning in Informal Settings
16. International Perspectives
17. Various Topics Physics Education

PLENARY SESSIONS

PS01

Plenary Session 01

Date & Time: 01.07.2012 / 16:00 - 17:00
Room: B CONF (Auditorium-I)

Context and Culture

Edward F. (Joe) Redish
University of Maryland, US

Edward F. (Joe) Redish is a Professor of Physics at the University of Maryland in College Park. He received his Ph.D. in theoretical nuclear physics from M.I.T. and has been in the Physics Department at the University of Maryland for over 40 years. He has made contributions to many areas of physics education research and has developed a variety of teaching materials including a guide to physics instruction, Teaching Physics with the Physics Suite. He is currently working on a prototype physics course for biology majors and premedical students as part of the NEXUS project. He has received numerous awards for his work in education including the Millikan Medal from the American Association of Physics Teachers, the NSF Director's award as a Distinguished Teaching Scholar.

PS02

Plenary Session 02

Date & Time: 02.07.2012 / 09:00 - 10:00
Room: B CONF (Auditorium-I)

How Technology Will Disrupt Physics Education

Robert F. Tinker
The Concord Consortium, Inc. US

Bob Tinker has, for thirty years, pioneered innovative approaches to education that exploit the power of technology. He invented the idea of using probes, including the ultrasonic motion detector, for use in education. He was the first to use networking to permit students to collaborate worldwide on science investigations. Seventeen years ago he started the nonprofit Concord Consortium to concentrate on innovative applications of technology in education. The Consortium specializes in online learning, the use of sophisticated simulations in science, probeware and handhelds, and applications of these technologies to pressing educational issues at all educational levels. He led the team that originated the Virtual High School and created the teacher professional development model that it uses. He has led the development of computational models that are widely used in education, including the award-winning Molecular Workbench. A common thread of technology, innovation, social need, and potential impact runs through all his work. Bob earned his PhD in experimental low temperature physics from MIT and has taught college physics for ten years.

Keywords: technology, education

PS03

Plenary Session 03

Date & Time: 03.07.2012 / 09:00 - 10:00

Room: B CONF (Auditorium-I)

Curriculum Development in Physics: Not Quite so Fast

Jon Ogborn

University of London, UK

Jon Ogborn is Emeritus Professor of Science Education at the Institute of Education, University of London. In the late 1960's he was, with Paul Black, responsible for leading the team developing the new pre-university curriculum "Nuffield Advanced Physics". Then, at the end of his career, he led a new team that developed the course "Advancing Physics", for the UK Institute of Physics. In between, he followed many research interests, including computational modelling, the origins of students' naive ideas in physics, and explanation in the science classroom, besides contributing to ideas about the basis of curriculum choices.

Keywords: Curriculum Development

PS04

Plenary Session 04

Date & Time: 04.07.2012 / 09:00 - 10:00

Room: B CONF (Auditorium-I)

Cross Cultural Investigation of Student Understanding

Pornrat Wattanakasiwich
Chiang Mai University, Thailand

Pornrat Wattanakasiwich primary area of expertise is in investigating students' understanding of thermodynamics, quantum mechanics and electricity and magnetism across Thailand, Australia and Laos. She had extensive experience in active learning, particularly using Interactive Lecture Demonstration (ILD) in large classes. Based at the Department of Physics and Materials Science, Chiang Mai University, Thailand and affiliated with Thailand Center of Excellence in Physics (ThEP), she has supervised master and PhD research students and received several grants to conduct physics education research in both Thailand and Laos. She received a 2011 Endeavour Research Fellowship Award from Australian government to conduct a physics education research at the University of Sydney. She also has been involved in organizing physics teacher workshops in Thailand and Laos. Pornrat got her PhD in physics education research from Oregon State University and has teaching experiences both in US and in Thailand for the past 10 years.

PS05

Plenary Session 05

Date & Time: 05.07.2012 / 09:00 - 10:00

Room: B CONF (Auditorium-I)

A Lifetime Search for PCK and Physics Representations across Contexts and Cultures

Ed Van Den Berg

Vrije Universiteit, Amsterdam, The Netherlands

Ed van den Berg (1951) currently holds appointments in secondary physics teacher education at the Vrije Universiteit (Amsterdam) and in primary teacher education at the Hogeschool van Amsterdam. In the past Ed studied Physics in the Netherlands and Science Education in the USA; taught high school physics; worked for Unesco in Kenya; and assisted in the development and teaching of Physics Teacher Education programs in Indonesia (1981-1991) and the Philippines (1996-2002). Ed also worked as physics teacher educator and developer at several Dutch universities. He published on physics teacher education, use of the laboratory in physics, fast feedback formative assessment, and served on the editorial boards of the JRST, ISJE, and the J of Sc T Ed.

Keywords: PCK, professional development

PS.I.a
Plenary Symposium - I
Date & Time: 02.07.2012 / 10:30 - 12:00
Room: B CONF (Auditorium-I)

The effect of connected computational technology on learning physics: demonstrated learning gains, reasoned expectations and thoughtful projections

Francisco Esquembre[1], Wolfgang Christian[2]
[1]Universidad De Murcia
[2]Davidson College

Francisco Esquembre is Associate Professor of Mathematical Analysis at the University of Murcia, Spain, and Dean of its Faculty of Mathematics. He teaches mathematical analysis and numerical algorithms of continuous and hybrid systems and is the creator of Easy Java Simulations. He served as General Director for Universities and Research at the Murcia Regional Ministry of Education and later as Director of the Office for Transfer Research of his university. Wolfgang Christian is the Brown Professor of Physics and Chair of the Physics Department at Davidson College, a Fellow of the American Physical Society (APS), and president- elect of the North Carolina Section of the American Association of Physics Teachers. He is the creator of Physlets and the author or co-author of nine books. Christian and Esquembre have worked together for over a dozen years creating interactive Java-based educational materials for the ComPADRE National Science Digital Library. In recognition of this work, they were awarded a SPORE Prize (Science Prize for Online Resources in Education) in the November 2011 issue of Science.

Motivating Computational Physics Education using Angry Birds, Rockets and Colliding Galaxies

Wolfgang Christian[1], Francisco Esquembre[2]
[1]Department of Physics, Davidson College, Davidson, United States
[2]Department of Mathematics, Universidad de Murcia, Murcia, Spain

Computational modeling has broad appeal since it is an effective way to develop problem solving skills and students perceive that they are not well educated without a good understanding of a computer's power and its limitations. However, a computer-based modeling approach to teaching must be flexible because students have different skills and varying levels of preparation. Learning syntax and numerical methods is not the primary goal of teaching computer-based modeling. Learning how to communicate an idea by using and eventually designing and building a computer model is. Some students write well, other students have good graphical design skills, and other students have mathematical ability, and a skilled instructor should use all these talents when designing curriculum. This paper describes no-cost open-source tools aligned with a modeling cycle pedagogy that does this [1]. These tools, curricular material, and ready-to-run examples are available at from the Open Source Physics Collection of the National Science Foundation funded ComPADRE National Science Digital Library at:
<http://www.compadre.org/osp/>.
[1] Christian, W., Esquembre, F., Barbado, L. (2011). "Open Source Physics," Science, 25, Vol. 334 no. 6059 pp. 1077-1078.

Symposium on Multimedia Teaching and Leaning of Physics

Francisco Esquembre[1], Wolfgang Christian[2], Anne Cox[3], Sebastian Dormido[4], Ewa Kedzierska[5], Fu Kwun Hwang[6]
[1]University of Murcia, Murcia, Spain
[2]Davidson College, Davidson, North Carolina, USA
[3]Eckerd College, St Petersburg, Florida, USA
[4]Spanish National Distance University, Madrid, Spain
[5]CMA, Amsterdam, The Netherlands
[6]National Taiwan Normal University, Taipei, Taiwan

We present four talks related to the different uses of multimedia in the teaching and leaning of physics. The symposium is presented by members of the MPTL group and covers four areas of interest: modeling and simulation, remote laboratories, video, and dissemination.
We will provide a review of the state of the art of each of the areas discussed, together with our vision of how the topic contributes to better teaching and learning of physics.

Keywords: multimedia, modeling, remote laboratories, video, dissemination

PS.II.a
Plenary Symposium - II
Date & Time: 03.07.2012 / 10:30 - 12:00
Room: B CONF (Auditorium-I)

Plenary Symposium II: Developing curricula whilst respecting research insights

Maarten Pieters
The Netherlands Institute for Curriculum Development SLO

A comparison of cases in 21st century oriented secondary education physics curriculum development across various countries
Contributors
• Uygar Kanli, Gazi University, Ankara, TURKEY
• Maarten Pieters, Netherlands Institute for Curriculum Development SLO, Enschede, NETHERLANDS (symposium organizer)
• Maurício Pietrocola, University of São Paulo, São Paulo, BRAZIL
• Jacqueline D. Spears, Center for Science Education, Kansas State University, Manhattan KS, USA
• Junehee Yoo, Seoul National University, Seoul, KOREA

Design
Physics curriculum developers from various parts of the world go into
• characteristics of their country's secondary education physics curriculum, its relation with economic and political motives, as well as with educational research outcomes
• motivations for renewing secondary physics education for their country
• where traceable and relevant: ways in which the organization and responsibilities of curriculum development in the countries influence the modernization of curriculum content.
The contributors each give a short presentation of main topics from their own country's situation. In discussion with the plenum we try to identify effective ways for characterizing physics curricula and link the characteristics to the variety of context elements from the societies.
From trends analysis to recommendations
Trends from society
In many countries, modernization of science curricula is promoted by governments, companies and science associations, as a support for our countries becoming stronger economies, better equipped for the globalized 21st century. Modernized curricula are to improve the quality of education, but should also attract more young people to science and technology careers. In some countries, also parents take part in the discussion; in other countries, parents are completely absent in the development process.
At the same time, curriculum innovations try to incorporate suggestions produced by research, in particular the one to connect concept learning to well-chosen topical contexts from daily life, the professional world, scientific research and technological development.
An interesting question is to what extent economic, cultural and political motives noticeably influence the development of secondary education science curricula, or more in particular physics curricula.
Trends from research
A perpetual question for educational researchers is: to what extent do research outcomes influence curricula and the process of curriculum development? Can trends in research or traces from its outcomes be found in new curricula? Which factors stimulate or inhibit their use?
Science education researchers sometimes meet with scepticism in society, including the science community itself. But educational research outcomes may also coincide with trends from society, in particular where society asks for evidence based improvement of curriculum design.
Suggestions and recommendations
Curriculum developers typically are squeezed, between
• expectations from society
• design criteria, as interpretations from research outcomes
• constraints in time and finances (pilots are expensive)
• professional and bureaucratic stakeholders to be involved
• teachers' expectations and sensitivities.
Given the trends above, and our analysis in terms of characteristics, what would our recommendations to curriculum developers for the next decades be?

Keywords: Physics curricula, international perspectives

WG-I.01
Date & Time: 02.07.2012 / 16:30 - 18:00
Room: D404 (3rd Floor)

WG-I.02
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: B CONF (Auditorium-I)

WG-I.03
Date & Time: 05.07.2012 / 16:00 - 17:30
Room: D404 (3rd Floor)

Workgroup I: Pedagogical Value of Using Computers to Learn Physics

Ronald K. Thornton
Tufts University Center for Science and Mathematics Teaching, USA

Coordinator: Ronald Thornton is the director of the Tufts Center for Science and Mathematics Teaching and a professor in both Physics and Education.
Tufts University, Medford, MA 02155. ronald.thornton@tufts.edu

Information and Format:

Four core topics in Physics Education have been selected; for each of them a Working Group is offered.

The forth topic is "The effect of connected computational technology on learning physics: demonstrated learning gains, reasoned expectations and thoughtful projections. [Computers are disruptive toys and powerful tools, but disruptions can be positive ways for change. What evidence is there that computers have had lasting pedagogical value in the context of learning physics?] "

Each Working Group (WG) is articulated in three sessions, each lasting 1.5 hours, to be held on different days. The participants to WCPE have the option to take part in a WG. All participants in a WG have the opportunity to give, in advance, a contribution on paper and also a five-minute oral presentation during the sessions.

For this WG, please send your proposal to the coordinator; a one page abstract is sufficient. A selection will be done, if needed.

The coordinator will chair the three WG sessions. A rapporteur will be chosen amongst the participants; s/he will prepare, together with the coordinator, a report on the WG activities and a short presentation about its conclusions, to be given during the last day of WCPE.

Objectives of the WG "Pedagogical Value of Using Computers to Learn Physics"

- explore the different uses of computers in physics instruction
- discuss and present the evidence for student learning from perspectives of Physics Education Research (PER)
- discuss appropriate methods of evaluating student learning in computer supported learning environments.
- to discuss possible future activities in the framework of international cooperation

All activities of the WG will aim at creating a cooperative and collaborative spirit and environment; the participants are kindly invited to share this objective and contribute to its realization.

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WG-II.01
Date & Time: 02.07.2012 / 16:30 - 18:00
Room: D405 (3rd Floor)

WG-II.02
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: FAZIL SAY (Auditorium II)

WG-II.03
Date & Time: 05.07.2012 / 16:00 - 17:30
Room: D405 (3rd Floor)
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Workgroup II: Developing the teachers: physics PCK development across a career

Elena Sassi
Department of Physical Sciences, University Of Naples "federico Ii", Napoli, Italy

Information about the workgroup and the format:

Two core topics in Physics Education have been selected; for each of them a Working Group is offered.
The second topic is "Professional Development of Teachers: Physics PCK across a career" (What's the state of the art in developing PCK and how well grounded is that art ?)
Each Workgroup (WG) is articulated in three sessions, each lasting 1.5 hours, to be held in different days.
The participants to WCPE have the option to take part in a WG. All participants to a WG have the opportunity to give, in advance, a contribution on paper and a five minutes presentation during the sessions.
For this WG, please send your proposal to the coordinator; a one page abstract is sufficient. A selection will be done, if needed.
The coordinator will chair the three WG sessions. A rapporteur will be chosen amongst the participants; s/he will prepare, together with the coordinator, a report on the WG activities and a short presentation about its conclusions, to be given during the last day of WCPE.

Objectives of the WG "Pedagogical Content Knowledge (PCK) and Teacher Education":
- to reflect on the role and relevance of PCK in Physics Teacher Education (pre-service and in-service)
- to address the status of the art in the developments of PCK, also in relation with studies and proposals in Physics Education Research (PER)
- to discuss possible future activities in the framework of international cooperation
- to propose guide-lines for the above identified activities

All activities of the WG will aim at creating a cooperative and collaborative spirit and environment; the participants are kindly invited to share this objective and contribute to its realization.

Elana Sassi is a full professor of physics education at University of Naples "Federico II", retired November 2009. Coordinator of the research group "Physics Education" at Physics Department.
Very many University courses: General Physics, Lab-work; Physics Education, …
Former experimentalist in Particle Physics at CERN and LNF Frascati.
Coordinator of research lines in several Italian projects, mainly focused on Active Learning and Real-Time lab-work, Teacher Education. In (1998- 2011) participation to seven EU Projects.

International Teacher Education Projects:
GULUNAP-SCIENCE, scientific-educational project (Universities of Naples and Gulu, Uganda);
PHYSWARE (http://cdsagenda5.ictp.trieste.it/full_display.php?ida=a07137) ICTP Trieste 2009
MUSE More Understanding with Simple Experiments (European Physics Society- Physics Education Division). (http://education.epsdivisions.org/documents/more-understanding-with-simple-experiments-muse)
Member of EPS-PED (http://education.epsdivisions.org/board/members/); ICPE, Commission on Physics Education, IUPAP up to 2011).
Author or co-author of about one hundred publications; educational software; contribution to books.

Keywords: Professional Development of Teachers, Physics PCK across a career, Teacher Education

PARALLEL SESSIONS

JULY 1, 2012
SUNDAY

PS.01.01.W

Strand 17: Various Topics in Physics Education

Parallel Session 01.01 Workshop
Date & Time: 01.07.2012 / 14:00 - 15:30
Room: D406 (3rd Floor)

How can it be? Teaching/learning physics by interactive demonstrations

Inese Dudareva[1], Paulis Paulins[1], Ausma Bruneniece[2], Andrejs Salszirnis[3]
[1]Department of Physics, University of Latvia, Riga, Latvia
[2]Pumpuri Secondary School, Jurmala, Latvia
[3]1 st Gymnasium of Jelgava, Jelgava, Latvia

How can you see invisible physical processes? How to create motion graphics? How can you find a black cat in a dark room? Is it really possible that the ball after rebound against the ground can jump higher than the height from which the ball is dropped?
One acquires best of all the knowledge, in which he believes undoubtedly. The best motivation of cognition is the natural human curiosity, which is the only direct, immediate motivation. Both the believing and motivation by curiosity are combined in the experiment, which arises /creates surprise and in which the student can be engaged himself and can take part actively. It can be a lab. As well it can be the demonstration of the experiment that stimulates the student:

* to search on his own the explanation of what he has seen;
* to join in the discussion;
* to test other versions of the experiment;
* thus to come to the understanding of the demonstrated phenomenon.

The undoubted belief is achieved, because the student sees the process with his own eyes, can hear it and touch it with his own fingers. He can also demonstrate it to the other students. Such experiments must be demonstrated at the beginning of each new topic, not only as an illustration in the end of the theoretical part. Students improve their understanding of physics, when they observe the demonstration of process and try to explain the observed using physics concepts, theories and patterns by themselves.
The participants of the workshop will be engaged in the demonstrations of the experiments just in the way described above, that will allow them to carry out such demonstrations by themselves at their classes. The numerous demonstrations will be presented using school demonstration equipment in physics with and without ICT and participants will be guided to tray these experiments in practice in the workshop. Examples of worksheets for students as well as detailed descriptions of tasks will be distributed.

Keywords: interactive demonstrations, active learning

Low cost laboratory activities

Alexander F Burr
Physics Department, New Mexico State University, Las Cruces, NM, USA

Everybody agrees that physics in a laboratory subject. However the cost of modern laboratory equipment and the class time involved is high. That means that some high schools and small colleges with budget problems wish the laboratory would just go away. This attitude is devastating, particularly for the general education student. Everybody needs to know that you can ask nature questions, and that nature will answer. This workshop is designed for general physics teachers. The participants will do experiments which are extremely simple. These experiments can also be analyzed in very sophisticated ways. The equipment required will be minimal. It will show the participants that laboratories can be both inexpensive and pedagogically useful.
Much has been written about more detailed goals for a physics laboratory. One short, readily available, description of a reasonable set of goals is available on the Inter-net at the URL http://www.appt.org/Resourses/policy/goalsof labs.cfm.
Fancy expensive equipment is not needed. Indeed sometimes it can get in the way of really learning the physics and the experimental techniques. During this hour we will learn to use very simple equipment to learn about some of the answers which nature gives.
1. Simple Pendulum
The workshop, with everyone participating, will explore the basic properties of a pendulum. They will determine the relationship between the period and the mass, the length, the acceleration of gravity, and the amplitude. All will be done using just a ruler, golf ball, screw, washers, string, and a stop watch. One goal of this experiment is to show that, even with the simple equipment used here, one can learn a lot about the effect of amplitude on the period. Many aspects of data analysis, some quite sophisticated, will be illustrated.
2. Spring constant
This experiment just uses a small spring, rubber band, paper clip, ruler, paper cup, washers, and a stopwatch to illustrate a number of ideas related to springs. Among the ideas discussed will be Hook's Law and its limitations. Again the data analysis, some of it quite sophisticated, will be illustrated.
3. Probability
If time permits, an unusual aspect of conditional probability will be illustrated with the Monte Hall problem. This problem, involving the selection of an object from three possibilities, has an interesting history. The answer will be experimentally found. In this case only a coin, one die, and paper are needed.
At the close of the hour, a number of experiments, again using just simple equipment, will be briefly described. Many of these experiments can be done at home or outside the class room. Details of these additional experiments will be available on the internet at the URL http://labs.qzx2.com.
Enough equipment will be provided so that all attending can fully participate in doing these experiments.

Keywords: laboratory, low cost, general physics, data, simple equipment, statistics, probability, spring, pendulum

PS.01.03.W

Strand 6: Secondary School Physics

Parallel Session 01.03 Workshop
Date & Time: 01.07.2012 / 14:00 - 15:30
Room: D506 (4th Floor)

Inquiry Based Science Education for Physics teaching and learning – the ESTABLISH Approach

Ton Ellermeijer, Marian Kires, Ewa Kedzierska, Martin Lindner, Zuzana Ješková, Claudio Fazio, Leos Dvorak, Eilish Mcloughlin
Foundation CMA, Amsterdam, The Netherlands

Inquiry-based teaching is an organized and intentional effort on behalf of a teacher to engage students in inquiry-based learning. The goal of inquiry teaching is not solely to transfer scientific knowledge, facts, definitions, and concepts, but rather to enhance students' ability to reason and to become independent learners who are capable of identifying main questions and find relevant answers by a gradually acquisition and expansion of a body of scientific knowledge and abilities. It is a student-centered approach to science learning and a range of types of inquiry activities exist, which correspond to the degree of teacher's guidance and student independence involved.

This workshop will discuss the approach adopted by consortium members of the FP7 ESTABLISH project from across 11 European countries, to address the challenge of implementing IBSE on a wide scale across Europe. Initially an agreed understanding of IBSE was reached by the consortium members through the adoption of a single definition of inquiry. Inquiry as "the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments".

This interpretation of IBSE is incorporated into an agreed framework, details of which will be presented, for the development of ESTABLISH IBSE teaching and learning units. These

IBSE units are used in teacher education to support teachers in implementing IBSE in their own classrooms. In addition to addressing core concepts in science, each unit includes industrial content knowledge to incorporate authentic learning experiences, and in case appropriate ICT-enabled activities (measurements with sensors, from videos and modeling activities). Results for the use of these units in physics teacher education both at pre-service and in-service will be presented. The experiences from the implementation of Physics IBSE Units in the class will also be presented. During the workshop participants can study the Units on-line and also study teacher training materials, for instance for teacher workshops for the use of ICT.

JULY 2, 2012
MONDAY

PS.02.01.W

Strand 10: Physics Curricula

Parallel Session 02.01 Workshop

Date & Time: 02.07.2012 / 13:00 - 14:30

Room: D501 (4th Floor)

Modeling What You See with Tracker

Anne J Cox

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Videos of Angry Birds, roller coasters and shark breaches are all opportunities to teach physics. In video analysis, students see physics in action as they collect kinematic data from these videos, creating graphs of velocity, acceleration, energy and momentum. Video modeling takes this one step further by combining videos with computational modeling. Here students apply a dynamic model to the video in an attempt to fit the motion observed. In this workshop, participants will use Tracker, a free, open-source video analysis and modeling tool, to analyze videos for use in the physics classroom. Tracker and ready-to-run curricular materials are available from the Open Source Physics Collection of the National Science Foundation funded ComPADRE National Science Digital Library at: <http://www.compadre.org/osp/>.

Keywords: video analysis, computational models, curriculum development, open source tools

PS.02.02.a

Strand 2: Teaching Physics Concepts

Parallel Session 02.02
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D404 (3rd Floor)

The Cosmological principle as a tool for teaching modern Physics concepts in Primary Education

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Astrophysics is one of the fields where 20th century Physics is fundamentally different from the Physics that preceded it. Currently elements of modern Astrophysics are mainly taught at the Secondary Education level, and usually in the latter years of that level. It is widely accepted that children form their own concepts about the Universe, by combining their personal experience of the world with their cultural and social context. The persistent nature of these self-developed ideas is also recorded. However research at teaching Astrophysics at the Primary Education level with the aim to influence or correct these self-developed concepts early, is not frequent.
Cosmology, an important field in modern Astrophysics, has the following advantages as a teaching subject:
a) It is an active research field, and its results frequently reach the public through the press, outreach activities or even their integration in popular culture.
b) Its theoretical nature complements well the experimental investigations that are now a significant part of the physics lesson.
c) It can serve as a basis of interdisciplinary cooperation within the school and intercultural communication between pupils in different countries and cultures.
d) It deals with the origin and development of the Universe, and can be used to engage with deap-seated cultural backgrounds.
We propose using the Cosmological Principle (CP) as a teaching tool to develop teaching Cosmology at the Primary School level. It states:
"Cosmological Principle: On large scales the Universe is homogenous and isotropic."
The CP can be used to introduce into the Physics lesson:
a) Basic knowledge about the Universe as a physical object.
b) The concept of scale.
c) An investigation of three-dimensional space, which can be combined with the current trends of introducing three-dimensional geometry early on in the Mathematics lesson.
d) The concepts of homogeneity and isotropy, which are also linked to the concept of transformation.
e) Discussion of the relation between scientific language and everyday language, and the differences between the two.
We propose teaching the CP by dividing it in four modules, formed by the main components of the formulation of the CP. Each of these modules is autonomous, thereby adding flexibility in implementing the proposal, and will consist of age-appropriate activities. This structure also allows expansion and addition, either in later classes or according to available resources and student interest.
Module "Cosmological Principle": This module can be broken down into two components, one examining Cosmology and another examining what a Principle is. In the first, the field of Cosmology is presented and used as an example to also discuss how Physics is composed of many fields, each investigating particular types or ranges of phenomena. This is extended to discuss the different importance of the opinion of an expert against a non-expert. In the second, the definition of a Principle is given, and compared to other uses of the word. This opens up the investigation of how scientific language differs from non-scientific language. This discussion is expanded to other terms to give pupils knowledge of the vocabulary of Physics theories.
Module "In Large scales": This module explains the concept of scale, as well as that of local variation. It can be coordinated with similar subjects in other lessons, such as Geography. Objects and localities close to (or in) the classroom can be used to show the changes observed between examining objects on a larger scale or up close.
Module "The Universe": In this module a description of the Universe is given, including the knowledge that a significant portion of the Universe is not directly observable. Activities are conducted to describe how gravity works at a distance (for example with a simplified Cavendish device) and to show how scientists can infer the mass or other physical properties of objects that are not visible.
Module "Homogenous and Isotropic": The concepts of homogeneity and isotropy can be explained independently, or can be combined with corresponding subjects or activities from the mathematics and geometry lesson. Activities with pupil participation, like games, can be used to reinforce their understanding.
After teaching of all modules in completed, the knowledge pupils have gained is combined into an understanding of the CP. In addition, this prepares the pupils to encounter other Astrophysics subjects in Secondary Education. It can also be expanded to teach other subjects from modern Physics.

Keywords: Astrophysics, Cosmology, Primary Education, Proposal, Basic Concepts

Contextual approach for teaching physics to non-major primary school student teachers

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The purpose of this paper is to discuss the use of the contextual approach in the teaching learning of physics at a teacher training institute in Malaysia. Trainee teachers at this teaching institute are taught Physics in Context in the third semester of their degree program. They must be equipped with the knowledge needed for teachers to teach physics which are the content knowledge and pedagogical content knowledge to ensure that they will be able to teach physics successfully in their own primary science classrooms. Thus it is essential that these future teachers be equipped with good content knowledge so that that they understand the physics concepts well to be able to teach these concepts in their primary science classrooms. The contextual approach was thus adopted in the teaching and learning of physics.
Using the contextual approach hoped to equip the trainee teachers with full understanding of the physics concepts. These contextual experiences make physics more meaningful to these trainee teachers as they promoted understanding, interests, ability to relate physics in their everyday life situations and solve physics problems. They will in turn able to convey these physics concepts contextually to their pupils, thus promoting understanding and interests among their primary school pupils.
This paper also discusses student teachers' perceptions and responses to contextual approach used in their physics course. Their responses were analysed qualitatively and quantitatively. Their responses indicated that learning physics contextually aided their understanding of the physics concepts and being given constant contextual exposure to physics helped them make sense physics, thus have better understanding and confidence to teach physics in their primary science classrooms. They also agreed that they will be adopting the same approach in their science classes.
The findings of the study indicated that using the contextual approach in teaching physics concepts to these trainee teachers aided their understanding, interest and mastery of the physics concepts. The trainee teachers claimed that they felt more confident to teach physics when they understood the concepts well and intended to use the same approach when teaching primary science physics. Using the contextual approach in the physics course is thus a part of the training process for these trainee teachers to conduct their own primary physics lessons contextually. Trainee teachers who have completed this course are well equipped with the appropriate content and pedagogical content knowledge to prepare them to teach physics at the primary school level

Keywords: contextual approach, student teachers, content knowledge, pedagogical content knowledge, primary science classrooms

PS.02.02.c

Strand 7: University Physics

Parallel Session 02.02
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D404 (3rd Floor)

Curriculum Innovation and Enhancement in the new Applied Physics Degree at the University of Portsmouth UK

Christopher Dewdney
University of Portsmouth

In 2010 the University of Portsmouth started a new degree in Applied Physics founded on the embedding of employability skills within the physics curriculum. The development work has been supported by the national HE STEM programme and the Institute of Physics and the european collaborative element by INTERREG. The aim of this presentation is to discuss and evaluate
the particular understanding of Applied Physics as a distinct discipline that underlies the degree
the theoretical basis of the degree in a specific understanding of the philosophy and sociology of science and of education research
the consequent implementation of the degree.
The fact that the degree has been created ab initio has allowed a rare occasion to bring together understandings of physics, physics education and employability in the development of the curriculum. The core of the curriculum is based around the enhancement of the student learning experience through the production of transformative curriculum materials founded on developing skills in the practical application of physics in the real-world industrial-problem-solving context through student-centred learning. The degree takes a new approach to laboratory physics, going beyond traditional set-piece experiments by focusing explicitly on the development of applied physics employment skills in a variety of contexts based on the importance of active learning and the use of "action-learning sets". The curriculum is informed by sustainable industrial and public sector collaboration in contexts in which the application of physics adds value. Industrial and service partners are engaged in both the development and the delivery of the curriculum. The importance of project design, computer-based data acquisition and instrument control for developing problem solving skills vital in employment is well known and National Instruments hardware and LabView software have provided an excellent platform for the development of such skills. Students gain valuable experience of the application of physics in wealth creation and human health and enhance their employability through the acquisition of vital skills that will ease the transition to employment.
The value of internationalism is recognized through the development of mixed national (UK-France) group problem-solving based projects that use 3D dynamics simulations devised for the project using the "Blender" software environment and the Moodle virtual classroom to allow international group collaborations.
The presentation will discuss and evaluate some particular case studies of curriculum materials developed for the degree within the laboratory and non-laboratory settings.

Keywords: University Physics Education Curriculum Development

PS.02.02.d
Strand 2: Teaching Physics Concepts
Parallel Session 02.02
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D404 (3rd Floor)

Overcoming Academic Misconceptions about the Learning and Teaching of Physics

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Although there is ample evidence that students have many misconceptions about their understanding of physics and that these misconceptions are difficult to correct using traditional teaching methods, many physics academics still persist with these methods. Education Research has reported on many active learning techniques [1] that appear to be much more effective than traditional methods in engaging students and in improving their conceptual understanding. Why then do so many Science Technology, Engineering & Mathematics (STEM) academics resist changing their traditional teaching practises, especially as STEM disciplines require a sequential learning strategy based on a sound understanding of fundamental concepts? In this paper, the authors argue that one of the main factors affecting this resistance to change is that the academics themselves have significant misconceptions about how students learn. A key misconception is that good information transfer equates to good learning. As a common example of this misconception, it is probably not surprising that even when academics are exposed to compelling Physics Education Research (PER) evidence [2] to the contrary, they appear to believe that this evidence does not apply to their teaching.

Academic misconceptions about student learning are a significant barrier to learning and teaching (L&T) improvement within the authors' institution. What is required is a persuasive mechanism to help academics correct their misconceptions about student learning.

In the authors' educational research, an active learning strategy (Interactive Lecture Demonstrations or ILDs) is used to supplement traditional lectures in an electronics course. The lectures in this course represent 60% of the instruction (with the remaining 40% divided equally between tutorial and laboratory classes). These 'consolidation ILDs' are designed to reinforce concepts that students have been exposed to previously in the traditional lectures. On a personal level, even though the authors understand the PER around active learning, it is still somewhat confronting when a large proportion of students make incorrect predictions around concepts that they have been 'taught' already via traditional lectures. The academic misconception that 'if you prepare a logical, coherent traditional lecture and deliver it in an enthusiastic and convincing manner, then the students will learn' is hard to overcome!

In 2011, an audience polling device system (clickers) was used for the first time with the 'consolidation ILDs' to give instantaneous feedback on student predictions. In addition, this instant feedback was a vivid reminder that students appeared to understand little from their traditional lectures. In this paper, the authors argue that clickers may be a very useful tool in helping academics to confront their L&T misconceptions. The next step is to encourage and mentor academics to try the new 'clicker' education technology [3], and in doing so help them address their L&T misconceptions. Part of this mentoring program will involve helping the academics to develop 'in-lecture' quiz questions that will test students' understanding of content and concepts that have been taught by the academic earlier in their traditional lectures. It is hoped that through this experience the authors will be able to understand how to help academics overcome their misconceptions about teaching physics, and hence help students overcome their own misconceptions about learning physics.

1. D. Zollman, "Millikan Lecture 1995: Do they just sit there? Reflections on helping students learn physics", Am. J. Phys. 64, 114-9 (1996)
2. R.R. Hake, "Interactive-engagement vs. traditional **METHODS:** A six-thousand-student survey of mechanics test data for introductory physics courses," Am. J. Phys. 66, 64-74 (1998)
3. K. Koenig, "Building acceptance for pedagogical reform through wide-scale implementation of clickers", J. Coll. Sci. Teach., 39, 46-50 (2010)

Keywords: Academic Misconceptions, Learning and Teaching, Clickers, Physics

PS.02.03.a

Strand 4: Laboratory Activities in Physics Education

Parallel Session 02.03

Date & Time: 02.07.2012 / 13:00 - 14:30

Room: D405 (3rd Floor)

Air Table: A Redesign of a Educational Laboratory Set

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Renko Ltd., Ankara, Turkey

Companies producing lab equipment have begun working on ways to integrate new technologies to their products by using touch screens, helpful software and adding data analyzer connectivity. Among these lab equipment that have been so far developed the multi-functional lab equipment the "Air Table" has not received any of the attention. On a "Air Table" one can do the following experiments; basic harmonic motion, the application and observation of Newton's 2ND law using the Atwood experiment, the calculation of the gravitational acceleration, angular velocity and rotational inertia observations, velocity and acceleration observations and calculations on a angular plane, projectile motion observations and calculations, collisions and the conservation of momentum, constant acceleration and linear motion observations and calculations, inclined plane experiments, constant speed and linear motion observations and related calculations. In this research we have further developed the common "Air Table" not only by changing the hardware but also adding software that we believe will revolutionize lab studies. Our novel approach will help out the teacher to teach the content while not hindering the students' on hands learning. This research consists of redesigning the "Air Table" and writing the software for the re-designed "Air Table" and some minor issues we have overcome related to the hardware and software integration, along with a proposal to further our studies. In the oral presentation we will also give a demonstration on how the new "Air Table" works and show how we used simple everyday tools to develop this lab experiment set.

Keywords: air table, lab education, development of physics lab equipment, tools to develop physics lab equipment

PS.02.03.b

Strand 4: Laboratory Activities in Physics Education

Parallel Session 02.03
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D405 (3rd Floor)

Experiential Learning of Classical Mechanics Through Molecular Dynamics

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We present a study of the use of molecular dynamics as a tool to teach concepts and practical aspects of classical mechanics to an inhomogeneous cohort of students. The cohort in the study consisted of five students, one senior, two juniors and two freshmen, neither of who intended to major in Physics. One of the students had two years of physics at high school, three of the students had two semesters of General Physics at the college level (mechanics and electricity and magnetism), and the remaining student had fulfilled all the physics requirements for graduation. The study was conducted over a period of ten weeks as a summer research experience for the students under the advisement of the authors of the present work. Classical molecular dynamics is a computational method used to simulate (integrate) Newton's second law of motion. In this study the students were asked to use the velocity Verlet algorithm to simulate different systems ranging from analytic and non-analytic textbook examples such as the motion of objects under gravity without and with air-resistance, the dynamics of our solar system to nominally research topics such as the melting of van der Waals clusters. The algorithm is based on writing the position, velocity and acceleration of the particles as finite differences. The resulting equations are very simple and resemble the equations of a particle moving under constant acceleration. We encouraged the students to discuss a variety of concepts such as the validity of the equations in the problems they were working on. The most advanced student was very comfortable with describing the problems using potential energy while the ones with limited physics coursework were more comfortable in understanding the acceleration in terms of forces. The discussion was very intense and the most outgoing students would take the lead and write their ideas on the blackboard. It was interesting to see how their understanding of the concepts of classical mechanics evolved in the ten week period. The more advanced students got a deeper understanding of concepts in the act of cognitive rehearsal when trying to make it clear to the novices how the use of energy is somewhat simpler than the forces in describing the dynamics of many particles. At the end of the ten-week period we could verify that the students got a deep understanding of the concepts as measured through in-group presentations and a university-wide symposium that marked the culmination of the summer research experience. Other gains were a firsthand experience with all the steps of the scientific method, learning new computational techniques and a programming language (C++), working on a linux operating system, and learning how to present their knowledge to an audience of different science backgrounds. We plan to continue this study over the next summer when a new cohort of students will be recruited, where we will further validate our findings by using pre- and post-testing of the cohort’s conceptual knowledge of classical mechanics.

We would like to acknowledge financial support from the Student Center for Science Engagement at Northeastern Illinois University (NEIU), funded by a U.S. Department of Education CCRAA HSI Grant.

Keywords: Experiential Learning, Molecular Dynamics, Classical Mechanics, Cognitive Rehersal

PS.02.03.c

Strand 4: Laboratory Activities in Physics Education

Parallel Session 02.03
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D405 (3rd Floor)

Teaching Physics with Soccer

Fabrizio Logiurato, Luigi Gratton, Mauro Rossi
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Soccer is considered one of the most loved sport in the world. With the aim to exploit such a popularity among High School students, we propose to analyze many physical aspects of this game. Connections with other sports are established as well. The study of physical phenomena in soccer is performed through simple experiments, digital analysis of images and videos with free software, and by watching famous soccer players' performances.
For instance, we study the kinematics and dynamics of a ball and other flight objects by considering the effects of air friction and fluid dynamics. Indeed, in the absence of wind we expect the trajectory of the ball to be in a vertical plane in the direction of the kick. Actually, a lateral force acts on a spinning ball in the air and this can curve the trajectory. Such phenomenon, known as Magnus effect, is observable in many ball sports, like baseball, tennis, table tennis and cricket, not only in soccer. We present some simple experiments in order to introduce such effect, together with some fundamental concepts of fluid dynamics. We developed a small device that allows us to launch spinning objects, like light expanded polystyrene glasses and little balls. Their trajectories are studied both qualitatively and quantitatively by comparing the experimental results with the theory of the Magnus effect. We also study the mechanics of the kick, the impulsive forces and the elastic and inelastic collisions. We make experiments on the mechanics of the bounce, on the conservation and dissipation of energy related to it, and on the effects of spin on bounces, as the "Maradona effect": a ball which comes back after its bounce.

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Keywords: Physics and Sports, Magnus effect

Smartphones used as individual experimental platforms when teaching classical mechanics

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Among the main topics taught in classical mechanics are: vectors, forces, motion, momentum, energy, angular motion, angular momentum, gravity, moving frames, and the motion of rigid bodies.
Beside one or two cameras and a microphone, most smartphones used daily by students include MEMS (MicroElectroMechanicalSystems) 3D sensors such as a accelerometer, a magnetometer and a gyroscope. Smartphones can send data of these sensors to a computer for treatment and visualisation at the rate of about 100Hz. This immediately means that the smartphone spatial orientation is known real time through Euler angles. Its acceleration vector is also constantly measured in 3D up to a point that real time numerical integration can be done to obtain the smartphone velocity vector and its position. Vector components of the gravity and earth magnetic fields are also available. In order to enter the moving frame investigation and the vector representation, we have developed a software that represents in real time during manipulation, the smartphone orientation and its two vectors: acceleration and speed. This is a scientific version of the iPhone presentation by Steve Jobs [1] where he says that thanks to all theses MEMS, the iPhone 4 is perfect for gaming. It is also perfect to teach physics and to experimentally approach space and time concepts, to investigate and describe object movements in frames. We have developed and tested lab sessions at the freshmen level in physics and mechanics at the University Joseph Fourier Grenoble France. Experimental ability of students has been evaluated on the basis of these practicals. Lab sessions have included: i) smartphone spatial position analysis through Euler angles, ii) measuring acceleration in an elevator (vertical velocity and position calculated using these data), iii) 2D rotation of swivel stool: simultaneous measurements of rotation angle θ, angular speed dθ/dt, and angular acceleration dθ2/dt2, iv) pendulum and mass-spring experiments to again measure and analyse acceleration, speed and position, v) determination of the friction coefficients.
Questions arise about pedagogical strategies: a) smartphones are general consumer products designed to enter our everyday life. To meet this goal, they have to be so sophisticated that they can be turned into a mobile personnel physics lab. A new look on technology presence in their life for young students. b) physics out of the lab: one can use smartphones with students to analyse displacement of cars, bicycles, skiers,. classical mechanics class and real life.

[1]-http://www.youtube.com/watch?v=ORcu-c-qnjg

Keywords: practicals, physics labs, classical mechanics, embedded sensors, smartphones: use of their integrated sensors and numerical environment as experimental platform

PS.02.04.a

Satrand 11: Motivational Strategies and Metacognition

Parallel Session 02.04
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D401 (3rd Floor)

Explicitly Emphasizing Metacognition and Epistemology in Inquiry-Based Physics Teaching: The Impacts on Students' Epistemological Understandings

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Theoretical Framework

A great deal of research studies and current educational reforms emphasize explicitly the importance of scientific inquiry and metacognition to science instruction. Many researchers urged the necessity of metacognition for inquiry skills (Baker, 1991; Schraw, Crippen, & Hartley, 2006; White & Frederiksen, 2000). Although it is suggested that inquiry-based teaching can be more effective when students are aware of their learning, and have monitoring and control on learning, few studies investigated the integration of inquiry-based teaching with metacognition. Moreover, students' epistemological understandings in physics affect their approaches to learning (e.g. Hammer, 1994, Lising & Elby, 2005). However, implicit instructions for improving students' epistemology were not effective compared to explicit instructions (Redish & Hammer, 2009). Therefore, in this study, the instruction method addressed explicitly on students' epistemologies to activate the productive resources used in their everyday reasoning. Similar to inquiry skills, metacognition is also needed for activation of suitable epistemological resources used in different contexts.

Purpose

This study described how 7E learning cycle model were integrated with metacognition and epistemology to make these two constructs explicit in the inquiry based physics instruction and to investigate the effect of this instruction on 10th grade students' epistemological understandings in physics.

The Research Problem of the Study

What is the effect of epistemologically and metacognitively stimulated learning cycle on tenth grade public high school students' epistemological understanding in physics?

Method

Participants

Participants of the study included 105 tenth grade students (48 female and 57 male) from four intact classes of two public high schools.

Instrument

To probe students' epistemological understanding, Maryland Physics Expectations-II (MPEX-II) survey was administered as pre-test prior to the intervention and as a post-test at the end of the intervention. MPEX-II developed by Elby, McCaskey, Lippmann, and Redish (2001) includes three sub-dimensions: (1) The coherence probing the extent to which the student views physics knowledge as coherent and sensible as opposed to a bunch of disconnected pieces, (2) the concepts probing the degree to which the student views concepts as the substance of physics as opposed to thinking of them as mere cues for which formulas to use (3) the independence probing the degree to which the student views learning physics as a matter of constructing her own understanding rather than absorbing knowledge from authority.

Research Design

A quasi-experimental with matching-only pretest-posttest control group design was employed. The classes were randomly assigned into experimental and control groups. The experimental classes were instructed using metacognitively and epistemologically stimulated 7E learning cycle while the comparison classes were taught based on the teacher-directed instruction. The study took about four months excluding the pre and post-test administrations.

Results

A One-way between groups multivariate analysis of covariance (MANCOVA) was performed to investigate the effect of the mode of instruction on students' epistemological understandings. Three dependent variables were used: students post test scores on coherence, concepts, and independence dimensions of MPEX-II. Students' pre test scores in these dimensions were used as the covariates in this analysis. The independent variable was modes of instruction. A significant difference on the combined dependent variables was observed between two groups. F (3, 100) = 8.82, p =.000; Wilks' Lambda =.79; partial eta squared =.209. When the results for dependent variables were considered separately, differences for coherence and concepts were statistically significant using Benferroni adjusted alpha level of.017. For coherence F (1,102) = 25.92, p =.000; partial eta squared =.203, for concepts, F (1,102) = 19.32, p =.000; partial eta squared =.159. The difference for independence did not reach statistical significance. F (1,102) = 4.34, p =.040; partial eta squared =.041.

Conclusion and Implication

The result of the study indicated metacognitively and epistemologically stimulated inquiry-based physics instruction was more effective for improving students' epistemological understandings about the structure and content of physics knowledge. All effect sizes for partial eta squared values for the statistically significant differences are large according to guidelines proposed by Cohen (1988) (small=.01, medium =.06=, large =.14). That is, the results of the study also have practical importance. This study proposed the new teaching strategy. Findings of study can be used for science education researchers, curriculum developers, and science teachers.

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Keywords: Metacognition, Epistemology, Inquiry-based Physics Teaching

IPITHIA - a new active learning strategy for a repetition course in mechanics for freshmen

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Introduction
For the last few years we have been facing the problems of lowering the level of science knowledge and competences of students entering Faculty of Physics, Astronomy and Applied Computer Science at the Jagiellonian University. As an answer to new demands in Winter 2009 a new strategy for a repetition course in mechanics was proposed to ensure equal initial opportunities for all freshmen undertaking studies in physics, astronomy, biophysics and nanotechnology. So far the course has been repeated three times and research on the course evaluation has been carried out.
IPITHIA learning strategy
Before the course a pre-test is carried out to screen the students who are good enough in mechanics and use different representations at ease, so do not need repetition in solving basic problems. For those who do not overstep a 50% threshold, the repetition course is obligatory and ends with a post-test.
Most of the groups are taught using a new active learning strategy, IPITHIA, based on a sequence of steps for solving simple theoretical problems: (1) Individual (work), (2) Peer Instruction, (3) Tutor/teacher Help and (4) Instruction (for) All (students). Using this approach most of the work is done within the first two steps and the forth step was reached only when the whole group of students encounters substantial difficulties while solving a particular problem. The third step involves individual work with a student and gives an opportunity to recognize and "untie" his/her conceptual knots. Some (reference) groups of students are taught traditional way, where most of the problems are solved on the blackboard by random chosen students and with much help of a teacher.
Results
To assess the new active learning strategy, we compared pre- and post-test results of two groups of students: one (N=59) trained with IPITHIA approach and the other (N-17) taught in the traditional way. The group average normalized gain factors, g-ave [1] found for both groups were 0.35 and 0.18, respectively, in consistence with other comparative studies between interactive engagement strategies and traditional courses in physics [2]. To evaluate the significance of this difference, an unpaired t-test was used and the results gave a value of $p=0.0014$ ($p<.05$), telling us that IPITHIA method was superior for teaching repetition course in mechanics to freshmen. Further, Cohen's effect size [3] value ($d=0.98$) suggested its high practical significance.
After the post-test, students participating in the course filled in an anonymous questionnaire. We learned from them that the groups taught in the traditional way found the course less motivating and explanations of problems less clear than the groups following IPITHIA.
Conclusions
We found IPITHIA strategy both more efficient and more motivating for students attending repetition classes in mechanics. We believe that proposed method is suitable for all kinds of repetition lessons not only at the academic level but also at earlier levels of education.
This work was supported by the Polish Ministry of Science and Higher Education, Project Wiking, POKL.04.01.01-00-355/09
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Keywords: course in mechanics, active learning strategy, gain factor, Cohen's effect size

PS.02.04.c

Satrand 11: Motivational Strategies and Metacognition

Parallel Session 02.04

Date & Time: 02.07.2012 / 13:00 - 14:30

Room: D401 (3rd Floor)

Investigation of the Effect of Students' Motivational Beliefs on their Metacognitive Self Regulation in Physics Courses

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Metacognition refers to the higher order thinking process involving self regulation of emotions, cognitions, learning. Metacognitive self regulation can be defined as a process in which students do self-monitoring on their own competence, make plans about what and how to learn and determine the goals for which strategies to use. Moreover, self regulated learning makes students metacognitively, behaviourally, and motivationally active participants in their own learning. Researches in recent years indicated that the use of metacognitive strategies is an effective factor on students' learning.

Studies on achievement motivation have focused on two contrasting motivational approaches: learning goal and performance goal. Learning goal is defined to be motivated to learn something new, try to understand learning activities and to improve their own abilities. On the contrary, performance goal focuses on motivation to demonstrate their own abilities and performances like getting high marks or being praised by others, being more successful than the other students. Recent researches indicated that achievement goals are significantly related to metacognition and students with learning goals have better metacognitive strategies that they use to master information than those students with performance goals. Other motivational construct, self efficacy belief is based on individuals' beliefs on their abilities and it is necessary for organizing and elucidating essential behavior for achieving the goal. Self-efficacy belief is defined as "the individual's belief in their capabilities for organizing necessary activities to display a certain performance and doing it successfully". In addition, researches indicated that students having high self-efficacy belief believe in achieving even harder works and this has a positive impact on their achievements. Research results showed that self-efficacy is related with metacognition as well.

The aim of this study is to investigate the effect of motivational beliefs on students' self regulation in physics courses. Therefore, the contribution of the students' learning goal, performance goal and self efficacy scores on their metacognitive self regulation strategies was investigated. The sample of the study consists of 187 university students taking physics course. Accordingly, 26 students from chemistry education department, 28 from biology education department, 36 from mathematics education department, 44 from primary science education department and 53 from primary mathematics education department took part in this study. Motivated Strategies for Learning Questionnaire and the Achievement Motivation Questionnaire were used as the instruments of this study. The students were requested to consider the strategies used by him or her in relation to the physics course. In order to assess students' metacognitive self regulation in physics, metacognitive self regulation subscale of Motivated Strategies for Learning Questionnaire was used. Its Cronbach Alpha was calculated as.79. The subscales of the achievement motivation questionnaire were used to assess students Learning goals, Performance goals and the Self efficacy in physics course. The Cronbach alpha reliabilities were.78 for learning goals,59 for performance goals, and.62 for self-efficacy.

The results of the study were evaluated by using SPSS with the help of the stepwise multiple regression analysis. The results showed that students' metacognitive self-regulation scores for physics were high and besides; their scores for learning goals were higher than those for performance goals. Moreover, stepwise multiple regression analysis revealed that learning goals and self-efficacy were significant predictors of students' metacognitive self regulation scores explaining 33% of the variance. The results of the study will be discussed to improve the quality of physics education.

Keywords: Achievement motivation, Metacognitive self regulation

Taxonomy of Physics Experiments in Inquiry-Based Science Education

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1 Conceptual framework
Some European universities report that the number of physics students has decreased by half since 1995. It is necessary to create effective educational methods that will increase student motivation. There is an innovative method called Inquiry-Based Science Education (IBSE) that, according to a number of surveys, increases and stimulates students' interest and teachers´ motivation. IBSE is suitable for all types of students: gifted and non-gifted, boys and girls, students of all ages. Physical experiments play a key role in IBSE because they have been the basis for inquiry.
2 Rationale
IBSE is based on understanding the process of learning science [5]. The principle of IBSE is the involvement of students in discovering natural laws, linking information into a meaningful context, developing critical thinking and promoting positive attitudes towards science ([4], [6]). Emphasis is placed on learning through inquiry and not through rote memorial learning. Individual applications of IBSE can be divided into student activities (Inquire-Based Science Learning) and teacher activities (Inquire-Based Science Teaching). IBSE combines both activities and includes the entire educational process. In terms of teacher involvement, there are four levels of IBSE: confirmation, structured, guided, and open [1]. Experiments and practical activities play a crucial role in all four IBSE levels because they are the basis of science inquiry.
3 Aim, questions and methodology
The aim of this study is to create taxonomy of IBSE experiments, to determine the role of experiments in IBSE and to establish principles and their applications. A mixed research method combining theoretical comparative analysis and design-based research has been used.
4 Notable ideas and conclusions
Taxonomy of experiments in IBSE
(1) Confirmation Experiments: students carry out experiments following teacher´s detailed instructions and under his/her direct supervision, the expected results of the experiments are known in advance, students confirm or verify laws.
(2) Structured Experiments: the process of experimentation is determined by the teacher, but the solution is not known in advance; the teacher significantly affects the students' research by asking guiding questions and by determining the way of research, students express their creativity in discovering laws.
(3) Guided Experiments: students propose their own methods and experiments to address research questions; the teacher cooperates with students to provide them with the research questions, gives advice on planning and implementation of the research.
(4) Open Experiments: Students form their own research questions, methods and process of research; they carry out experiments on their own.
Each type is supplemented by particular examples of physics experiments.
Principles of experiments used in IBSE
The taxonomy of experiments is supplemented by a set of principles for their application in IBSE. These include: selection of simple experiments from daily life, creation of alternative student experiments, functional use of ICT, etc.
5 Discussion and Implications
A subsequent research problem in IBSE is teacher proficiency in: combining experiments and problem tasks [2], simple experimenting [3], project teaching etc. It is necessary to implement principles of using experiments and their IBSE taxonomy in physics teacher training. We have been analysing the implementation of experiments in IBSE within the European project PROFILES [7].
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Keywords: experiments, Inquiry-Based Science Education, motivation, taxonomy, teaching/learning method

PS.02.05.a
Strand 7: University Physics
Parallel Session 02.05
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D402 (3rd Floor)

An inventory on angular velocity of a particle

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We developed an inventory to investigate student understanding of angular velocity of a particle. The motivation came from our experience that not only students but even teachers at pre-college level have difficulty with rotational motion in general [1–4]. Unlike basic Newtonian mechanics, elementary concepts of rotational motion did not receive enough attention from physics education research (PER) [2, 5]. Our work is similar in character to focused inventories such as Test of Understanding Graphs-Kinematics (TUGK) [6]. It should be contrasted with inventories which are broad survey instruments such as Conceptual Survey of Electricity and Magnetism (CSEM) [7]. We aim at probing deficiency in understanding angular velocity and elicit ill suited reasoning patterns. A formal knowledge of rotational kinematics is required to answer the items which makes it similar to Mechanics Baseline Test (MBT) in contrast with Force Concept Inventory (FCI) [8, 9]. The focus of FCI is on probing preconceptions incompatible with physics acquired tacitly over the years.

For developing the inventory we interacted with students as well as teachers and our aim was to understand the nature of difficulties so that proper questions/items as well as distractors could be framed. Some of the difficulties were identical to those reported earlier in the context of linear velocity [10]. This included problems dealing with simple ratios, concept of limit or the instantaneous aspect, position-velocity confusion etc. Others were peculiar to the characteristics of angular velocity among which the non intuitive nature of its direction of was a prominent hurdle. Difficulties in visualization were also observed. We also found indiscriminate usages of the equation $v = \omega \times r$ ignoring the fact that it is valid only for circular motion. We framed multiple choice questions and distractors (four) incorporating all these factors. The context of questions included real life examples like wall clock and physically relevant situations like pendulum, elliptical motion etc. Items thus developed underwent iterative modifications through pilot studies. The inventory was then content validated by experts.

The inventory constituting 10 items was administered to a set of 26 teachers and 90 students. The teachers taught physics either at pre-college or undergraduate level and were from across the country. The students were at pre-college level who have learnt rotational motion and constituted of 2 groups of 79 and 11. The group of 11 were among the top 300 from which the Indian team for international Physics Olympiad would be selected.

The data shows that teachers as well as students have difficulty comprehending the various aspects of angular velocity. It may be noted that the performance of the smaller group (11) of students was significantly better. Strikingly, there was no major differences between the performance of the larger group (79) and the teachers. This was inferred by calculating the difficulty level (= correct responses/ total responses) of each item for all the groups.

Some specific examples of the observed pitfalls include

- The tips of the minute hand and the second hand have same angular velocity when they are at the same position (12 O'clock).
- The direction of angular velocity of a pendulum bob lies in the plane of motion.
- Angular velocity of the tip of a clock (transparent) hand changes direction depending on whether one is looking from the front or the rear.
- The equation $v = \omega \times r$ holds true for a planet revolving in an elliptical orbit with sun as one of its foci.

An immediate corrective measure would be to emphasize operational definitions and accompanying procedural specifications [11, 12]. Concluding, we find that there is a need for firmer grounding of elementary concepts like angular velocity, angular acceleration etc. We intend to investigate rotational kinematics further.

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Keywords: inventory, angular velocity of a particle, pitfalls

PS.02.05.b

Strand 7: University Physics

Parallel Session 02.05
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D402 (3rd Floor)

Validating a Japanese Version of FCI with Cognitively Sequenced Questions

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Over the years, a variety of diagnostic tools have been developed in physics education in order to measure how student learning is improved. Among the diagnostic tools, the Force Concept Inventory (FCI) developed by Hestenes and his collaborators is a typical one to assess how students understand the Newtonian conceptual framework [1]. The FCI is a 30-item 5-choice survey, which can be solved almost without equations. The distractors of the questions are constructed based on the knowledge of the naïve conception of mechanics. The FCI has been translated into various languages, also into Japanese [2] and is widespread internationally in the field of physics education research.

In General, the validity of the diagnostic tool must be confirmed. Actually, the validity of the FCI has been evaluated from various points of views. For example, Hestenes and his collaborators evaluated the validity of the wording and diagram of the questions, that is, the validity of the representation of the questions and they explained it is beyond reasonable doubt [1,3]. Rebello and Zollman evaluated the validity of the distractors of the questions, by comparing students' responses on four FCI questions with similar responses to equivalent open-ended questions [4]. Stewart and his collaborators evaluated the validity of the contexts of the questions with a 10-question context-modified test [5].

In our last work [6], we evaluated the validity of the Japanese version of the FCI focusing on the representation, since the validity might vary depending on the group of the students. We set criteria, one of which is based on the false-negatives, false-positives [7], and guessing that came about from the inadequacy of the translation. We interviewed 16 students and found that, under the set criteria, of the 30 questions, 16 questions had at least one of these problems.

We could not evaluate statistically the validity, because the number of interviewees of our work, 16 persons, is not enough to give a persuasive conclusion. In order to increase the number of examinees, it is better to use a questionnaire. For example, we might use a questionnaire in which students write their responses and the reasons why they chose it in free description. In this case, however, there is a problem that students might not write all of their reasoning and we could not judge whether students really understand the physics concepts behind the question.

In this work, therefore, we suggest a new method to evaluate the validity of the representation of the FCI. In this method, we use a questionnaire which is constructed by subdividing a question of the FCI into cognitive units in order that we could judge whether students understand the physics concepts behind the question. Since these questions are sequenced in several cognitive steps, we call these questions cognitively sequenced questions. With this method, we can examine the false-negatives and false-positives systematically, and can increase the number of examinees enough to do statistical analysis.

In this talk, we explain our method by showing several examples of the cognitively sequenced questions and report the preliminary results of our research to more than 50 students in Meijo University. We hope your candid comments and questions.

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[7] The false-negatives are the wrong answers that the examinees chose with the logic based on the Newtonian mechanics. The false-negatives include the careless mistakes. The false-positives are the right answers that the examinees chose without the logic based on the Newtonian mechanics. Since the FCI has 5-choices, the false-positive appears in 20% even if the examinees choose randomly.

Keywords: Validation, Force Concept Inventory (FCI), Diagnostic Tool, Concept Surveys

Link Maps: Exploring the knowledge structures of introductory physics

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Nearly fifty years ago, Joseph Schwab (1964) argued for an increased focus on the nature of the subject matter itself in discipline specific research. In the Physics Education Research community, the nature of physics knowledge is still receiving far less attention than the teaching and learning of it. This presentation focuses on the knowledge structure of some of the physics taught in first year university. It provides a new, fruitful way of viewing physics knowledge, which is helpful when trying to improve student learning, and presents a new way of reflecting upon the first year physics curriculum for researchers and practitioners in physics education.

This presentation builds on a large institutional study in introductory physics where a new type of tutorials centred around two-dimensional, non-linear knowledge maps called Link Maps. These tutorials were found to have only half the number of students at risk of failing as measured by the final examination compared to the existing research based inquiry tutorials (Lindstrøm and Sharma, 2011). The focus of this presentation is to explore the way physics knowledge was organized in the Link Maps. In particular: can studying the knowledge structure of Link Maps shed some light on why they were experienced as being central to the success of the intervention? Two theoretical frameworks were used to analyse the knowledge presented in the maps. These originate from the works of Bernstein and Bloom. Bernstein characterized physics as having the most hierarchical knowledge structure of all disciplines, referring to “a coherent, explicit and systematically principled structure, hierarchically organized [that] (…) attempts to create very general propositions and theories, which integrate knowledge at lower levels, and in this way shows underlying uniformities across an expanding range of apparently different phenomena” (Bernstein, 1996, p. 172). Using Bloom’s taxonomy, it is possible to argue that it is the categories of declarative knowledge that are of interest here: Factual and Conceptual knowledge (as opposed to Procedural and Metacognitive knowledge) are explicitly presented on the Link Maps.

The key ideas in this presentation are the following. 1) The way Link Maps were constructed made explicit the integrated nature of physics knowledge – both within and between topics that were being taught – especially in the Mechanics module. It is proposed that this helped the students understand the material better. 2) It is educationally valuable to distinguish the knowledge structure of the discipline from the knowledge structure of individuals, especially when those individuals are students. Even though the knowledge of physics, as a domain, may be very strongly integrated (and thus referred to as hierarchical in the language of Bernstein), the knowledge of students is not necessarily well integrated at all. The teaching of the discipline is therefore not just about helping students learn ‘knowledge pieces’, but also about helping them organise this knowledge. 3) The type of knowledge that appears on Link Maps is almost entirely Conceptual knowledge (in term of Bloom’s taxonomy), much of which is quite abstract and often in mathematical form. An argument is made that it is this abstract knowledge that allows for the integrated nature to be presented in the condensed way that it appears on the Link Maps, but it is also this abstraction compounded with the integration that makes physics particularly challenging for students to learn.

A key implication for teaching and learning is the importance of specifying whether one is talking about the knowledge structure and content of the discipline itself (as contained within the community) or of the students of the discipline. When students construct their physics knowledge, how the content is mentally structured is a critical part of coming to understand it. It is therefore argued that it is valuable that the teaching of physics, in particular to novices,– in addition to focusing on content – explicitly presents how this content can be effectively structured in the endeavor align student learning with that of the discipline.

Bernstein, B. (1996). Pedagogy, symbolic control, and identity: Theory, research, critique. London; Washington, D.C.: Taylor & Francis.
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Keywords: introductory physics, knowledge structure, constructing physics knowledge, theoretical framework

PS.02.05.d

Strand 7: University Physics

Parallel Session 02.05

Date & Time: 02.07.2012 / 13:00 - 14:30

Room: D402 (3rd Floor)

Factors Associated With Physics Achievement Of Engineering Students In Ama International University-Bahrain

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Ama International University Salmabad, Kingdom of Bahrain

Introduction

Schools or universities are considered one of the most delicate enterprises because they are tasked with the development of human beings as educated individuals. The primary goal of education is to produce excellent outputs. Programs and projects have been created as means to improve quality of education.

One of the most common ways of detecting improvement in an institution is through measuring the students' achievement in a test. Testing is generally thought of as a means of assessing the knowledge and skills students have acquired through learning. Test results provide vital information that could be the basis for the following: (a) assigning final grade; (b) distinguishing students' strengths and weaknesses; (c) assessing class performance; and (d) improving teaching methods or techniques. Knowing the students' achievement more or less determines the kind of instructors the school has. To measure such achievement, a valid and reliable measuring device is needed.

The study deals with the analysis of factors associated with achievement in Physics of engineering students based on the content areas and on Course Intended Learning Outcomes; the implications of these factors; and the problems encountered by the students that affect physics achievement. The results may suggest a level of instruction appropriate for engineering students knowing the Course Performance Rating (CPR) in the natural sciences. Thus, this study will prove beneficial to the: (1) College of Engineering; (2) Department of Physics; (3) School Administrators; and (4) Physics Teachers.

Research Methods and Procedures

The descriptive – correlational method of research will be employed in this study. It is correlational because the study attempts to correlate some variables associated with the physics achievement of engineering students of AMA International University Bahrain.

The study will make use of the engineering students as respondents who are registered during the third semester of SY 2011-2012.

The achievement test in physics will be prepared by the proponent. The instrument will be pretested and validated by a group of students in the College of Computer Studies, which included experts in physics.

The study will employ statistical tools, namely the weighted mean, the standard deviation and the chi-square test.

Keywords: Physics Performance, Students' Achievement, Achievement Test

PS.02.06.S

Strand 3: Learning Physics Concepts

Parallel Session 02.06 Symposium
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D502 (4th Floor)

Pbl in mechanics: some results of a controlled experiment

Poutot Géraldine, Bacila Adriana, Ageorges Philippe, Blandin Bernard
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CESI School of Engineering decided to test the implementation of a Problem-Based Learning (PBL) approach in Mechanics for the first year students registered in 2010. The curriculum in Mechanics includes Statics, Kinematics and Dynamics. Six problems were developed by three teachers / researchers of the LIEA in France to cover the whole programme, and a measurement protocol was designed to compare two different approaches: Problem-Based Learning and traditional teaching: the students would have to take several tests to measure their mastering of concepts and principles of Newton's physics (FCI, MBT) together with assessment tests designed by the teachers and intended to measure their acquired knowledge and capacities in problems resolution. In order to establish a comparative analysis, the 2010-2013 cohorts of three centers were split into two groups, one following the PBL approach and the other one traditional teaching in each center. The FCI test was taken by all students before and after the course in Statics, the MBT test was taken by the same students before and after the course in Kinematics and Dynamics. Assessment tests were taken at the end of each part of the course. Our hypothesis was that both approaches would be identical in terms of acquisition of knowledge, but that PBL approach would allow improved conceptualization and reasoning in physics. The analysis of the three measures provides the following results.

- The FCI test taken before beginning to learn Statics showed that there wasn't significant difference between groups in terms of Newtonian conceptualization. It revealed a small improvement after the course, whatever was its modality. However an analysis of variance shows differences according to school's centers.
- The results of the MBT test were globally very weak and the difference between groups and centers is significant.
- Assessment tests were marked according to Rubrix grids intending to measure the learning outcomes. In spite of the hypothesis that these grids measuring the learning outcomes objective by objective were precise and detailed enough, discrepancies between the examiners appeared. These discrepancies are of high importance, as the mark is given on 4 points.

Finally, further experimentation is needed to provide statistical evidence that one method of learning Mechanics is more appropriate than the other. Beyond the quantitative results given by the tests and the assessments, qualitative results were gathered by observations and interviews of our students, by two students attending a Master course in Educational sciences, Beatrice Vicherat and Mathieu Gandon. According to them, it seems that the acceptance of the Problem-Based Learning method is a determining factor of its learning efficiency. The proposed paper will provide in more details the statistics as well as the observations and recommendations from the qualitative surveys.

Keywords: Problem-based learning, mechanics, Newton's physics tests, quantitative results, qualitative results

PS.02.07.W
Strand 2: Teaching Physics Concepts
Parallel Session 02.07 Workshop
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D504 (4th Floor)

Improve learning by using demonstrations

Matthew Bobrowsky
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Demonstrations are widely used in undergraduate physics classes throughout the world. Demonstrations are traditionally assumed to enhance students' interest as well as result in increased learning. However, previous studies have shown that unless the demonstrations are presented properly, their efficacy can be minimal, and in some cases there can be less understanding (due to the introduction of misconceptions) following a demonstration than before (e.g., Roth et al. 1997). On the other hand, when presented in a more engaging, interactive manner, demonstrations can be quite useful. Sokoloff & Thornton (1997) found, based on pre- and post-tests of students' understanding of dynamics concepts, that traditional instruction (without demos) resulted in only a 7-10% increase in learning, while the addition of interactive demonstrations boosted learning by an additional 45-75%. This increased effectiveness of interactive demonstrations was corroborated by Crouch et al. (2004).
This workshop will provide physics instructors with the tools needed to present demonstrations in an effective manner and achieve significant increases in students' comprehension of the relevant physics. To achieve this goal, demonstrations must provide an interactive — not passive — experience for the students. This is not a trivial matter. Most instructors do not engage their students when showing a demonstration, and if the students do not actively participate, their learning will not benefit from the demonstration (Kraus 1997).
At many institutions there is a very high rate of use of demonstrations in physics classes. In fact, some courses are primarily based on the use of demonstrations. (The presenting author is a veteran instructor of such courses – such as "The Physics of Music" and "Light, Perception, Photography, and Visual Phenomena.") The use of demonstrations is also very important in pre-medical and pre-engineering courses.
Additional interaction with the demonstration could, for example, have a student discuss the demonstration, which would allow both the instructor and the student to assess the student's understanding of the vocabulary, the scientific concept, and the relevance of the demonstration. It provides a formative assessment and can reveal misconceptions that the instructor can then address. However, the instructor needs to engage all students in answering and discussing the relevant science. Such participation is necessary for students to confront their misconceptions or simply to learn from the demonstration.
This workshop, in conjunction with the presenter's accompanying oral presentation ("Demonstrations can increase learning…or not") will provide participants with an excellent understanding of how to make demonstrations effective (when they otherwise would not be). Participants will gain experience using actual demonstrations and will practice presenting lessons using interactive techniques that engage and challenge students in ways that are now known to be essential for increased student learning.

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Keywords: Demonstrations, Pedagogy

PS.02.08.W

Strand 13: Philosophy, Nature, and Epistemology of Science

Parallel Session 02.08 Workshop

Date & Time: 02.07.2012 / 13:00 - 14:30

Room: D505 (4th Floor)

Communicating Nature of Science: "Hidden Container", an example for "black box" experiments in Science

Mansour Vesali

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The nature of science has been increasingly finding important and crucial role in science education in recent years. This can be seen both from the books which mainly concern on the NOS issues from theoretical point of view, and the place of NOS, its importance and role, in science education [W.F. McComas 2000; L.B. Flick and N.G. Lederman 2006], and also from the books which mainly concern about teaching and instruction of science in elementary, middle, and high school [D.M. Wolfinger 2000; E.I. Chiappetta, et.al 1998].
The nature of science is a blending arena of the history, philosophy, sociology, and psychology of science. Though accepted by many educators the importance and necessity of including NOS in science education programs, the question of "what" and "how-to" of communicating NOS with teachers and students has been remained as an important problem. For many teachers those introductory chapters of history and philosophy of science are considered as separate and extra sections which simply tell the story of science! Any suggestions in this regard should present the essential aspects of science every student should know and understand about science. How are theories built? How do scientists know about the things which we cannot access them directly? Why do people give different theories while they are using the same data? How do theories and models change? What does really mean that "scientific ideas while durable are tentative"?
This is in this connection which the idea of "black box" experiments finds an important role in communicating NOS concepts, issues and ideas. A "black box" is any devise which can be served to show how scientists actually talk about things which are hidden in the black boxes of the Nature. Black boxes can be/are very diverse in their structures, purposes, design, and people who are supposed to benefit from them.
The black box created and designed for this workshop is a container hidden in a box. The container cannot be accessed directly by, for example opening the box's door. There are only two ways we can "communicate" with the box: one is pouring a liquid -- water, alcohol, or the like -- from the top of the box which goes through a pipe into the container. The second way is a calibrated tube which is connected to the container in the bottom and is stretched in parallel to the box from the outside. (This is our detector!) There is also a gauge which is a small cup with a specific capacity or volume. (This is our probe!) The process is simple. When we pour the liquid, the water, say, is shared between the container and the calibrated tube. The height of the liquid in the tube depends on the diameter of the container: In the narrower parts the change of the height of the liquid is high. And in the wider parts the change of the height is low. Because of practical difficulties in building and bringing the box, participants will receive the data gathered by some other "researcher" who has "published" his data. Thus, participants will be engaged in a data processing and analyzing investigation. The data will be given in stages and the participants will have to change their models of the shape of the container in each stage. Although it seems simple, the activity is by no means trivial. In fact, the participants will face with some questions and points which challenge their account to the data and make them reflect on their inferences and judgments: On what laws or theories do their models rely? How does a new data make them change their models? In what ways do their models differ from each others? Are there any alternatives for their models? How will the changing of the probe affect the results of the experiment? Is our model an exact copy of the real container? (Can we ever be able to know the true shape of the container?) Are there any law(s) "governing" the container? These and other questions will be posed during the activity which will give some feelings of "how science functions".
Regarding the method of presentation the only materials for the workshop are some paper sheets, pen or pencil, a calculator (just for simple calculations), and some small rulers. The data recorded in tables will be given by the presenter. The presenter will also bring some rulers with him.

Keywords: Nature of science, Black box

Computer Models Design for Teaching and Learning using Easy Java Simulation

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We are teachers who have benefited from the Open Source Physics (Brown, 2011; Christian, 2010; Esquembre, 2010) community's work and we would like to share some of the computer models and lesson packages that we have designed and implemented in five schools in the grade 11 to 12 classes.
In a ground up teacher leadership (MOE, 2010) approach, we came together to learn together, advancing the professionalism of physics educators and improve students' learning experiences through suitable blended of real equipment and computer models. We will share computer models that we have remixed from existing library of computer models into suitable learning environments for inquiry of physics customized (Wee & Mak, 2009) for the Advanced Level Physics.
We hope other teachers would find these computer models useful and remix them to suit their own context, design better learning activities and share to benefit all humankind, becoming citizens for the world.
This is an eduLab (Wee, 2010) project funded by the National Research Fund (NRF) Singapore and Ministry of Education (MOE) Singapore.
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Wee, L. K., & Mak, W. K. (2009, 02 June). Leveraging on Easy Java Simulation tool and open source computer simulation library to create interactive digital media for mass customization of high school physics curriculum. Paper presented at the 3rd Redesigning Pedagogy International Conference, Singapore.

Keywords: Blended Learning, Simulations, Computer Models, Open Source Physics, Teacher Education, Tracker, Easy Java Simulations

PS.02.09.b

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 02.09
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D403 (3rd Floor)

Teaching High School Physics with OVPLE – The Online Virtual Physics Learning Environment

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With the advent of high speed, multi-media capable, light weight, less costly computers –and handy devices possessing such computing capabilities– students and teachers, just like all other people in all other sectors of the economies, are exploiting this computing power in all sorts of new ways. Teachers need to have competences in creating technology rich educational environments and using the technologies effectively during the lessons. These teacher competences are named as TPCK and can be described as how teachers understand educational technologies and use technology to produce effective teaching with technology. Recently, over several years, we produced a teacher development module on the use of interactive computer animations closely aligned with Turkish high school physics curriculum. The function of these animations is to clarify the concepts of physics and to give the ability of experimenting in the virtual space. By elucidating the underlying mechanisms of natural the phenomena within the computer environment, it is hoped that teachers and students will be more engaged in teaching and learning activities. Providing positive learning experiences to students is essential for them to understand the concepts of physics and choosing careers in the future. The module is available online and can also be used as the basis of teacher professional development workshops. It enables teachers to develop content knowledge as well as pedagogical approaches and tools for teaching physical phenomena. This module is targets and designed for grades 9-12 and covers great majority concepts of the Turkish physics curriculum. The virtual learning environment covers a total of over 100 animations and simulations (being almost evenly distributed to each grade) covering specific subjects and concepts by also targeting known student misconceptions and learning difficulties. In this workshop we will showcase the online virtual physics learning environment (OVPLE) for high schools. Each subject in the OVPLE contains an interactive animation or simulation, a user's guide, historical background of the subject, and theoretical explanation. In the workshop participants will learn about ways of effectively using the OVPLE and will have chances to interact with the development team.
Acknowledgement: This work is supported by TUBITAK under SOBAG 1001 Support Programme for Scientific and Technological Research Projects.

Keywords: ICT, mutimedia, animation, simulation, physics teaching, in-service teacher education

PS.02.09.c

Strand 9: Teacher Professional Development

Parallel Session 02.09

Date & Time: 02.07.2012 / 13:00 - 14:30

Room: D403 (3rd Floor)

Attempts of transforming teacher practice through professional development

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One of the most difficult challenges in physics education is to design professional development programs for teachers, which can lead to fundamental changes in their practice. We report all activities for physics teachers in the context of the National Plan for Scientific Degrees in Southern Tuscany. Research and practice have shown that physics teaching in school is inadequate. The main consequences are limited achievements in school (and often in universities), the decrease of students' interests in learning physics and the decrease of enrollments in physics, sometime impressive, in many countries. In recent years, the decline in enrollments in science degrees was faced up with the launch of a wide national project addressed to secondary school students and teachers. The plan is focused on the design and implementation of laboratory and teacher professional enhancement. The active involvement of teachers in the design of laboratories was found to be one of the essential points to make actions with students which were not transitory and entered permanently in classroom practice. We describe some advanced course in Physics and Mathematics Education designed for teachers realized few years ago and courses designed for a Master in Physics Educational Innovation and Orienting performed jointly by many italian universities. Other activities are less formal but equally relevant, such as the active involvement of expert, young and in training teachers in the design and implementation of laboratory activities for a summer school of physics. Recently, we developed a workshop for teachers of physics and mathematics on modeling. This activity has continued in an updating course for teachers in which selected topics, named in the same way in both disciplines, are discussed in order to design interdisciplinary learning paths. The purpose is to clarify these topics by using specific tools from physics and mathematics and to outline the similarities and the differences in both contexts. We believe that this activity can be useful for students, which can acquire a profound insight on some fundamental concepts, and for teacher professional development. We describe teacher reactions and the more significant difficulties we encountered. Finally, we discuss which kind of activity seems more effective.

Keywords: Continuous learning, Physics laboratory, Teaching methods and strategies, Professional development

PS.02.09.d

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 02.09

Date & Time: 02.07.2012 / 13:00 - 14:30

Room: D403 (3rd Floor)

Modelling Indicators and Metacognition Skills in Computational Science Inquiry Based Environments

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Over the past decade, increasing importance and attention has been attached to the potential of new technologies of information and communication (ICT) to improve teaching and learning in schools. According to Piet Lijnse (Girep, 2006, http://www.girep2006.nl/, Modeling in Physics and Physics Education), focus on modelling is largely due to the following reasons. One is the recent constructivist attention to conceptions that students bring to the classroom. A second is the present emphasis on the role of philosophy in science education, which has resulted in stressing the importance of attention for the nature of scientific models. Directly connected to that approach, is that proposed by (Landau et.al, 2008), as Computational Physics (CP). One of the crucial components of (CP) and the corresponding Computational experiment (CE), is the abstraction of a physical phenomenon to a conceptual model and its translation into a computational model that can be validated. This leads us to the notion of a computational experiment where the model and the computer take the place of the 'classical' experimental set-up, and where simulation replaces the experiment as such. According to Hestenes (1999) traditional physics courses lay heavy emphasis on problem solving and this results to the undesirable consequence of directing student attention to problems and their solutions as units of scientific knowledge. Modelling theory tells us that these are the wrong units; the correct units are the models. Problem solving is important, but it should be subservient to modelling. Hestenes (1999), states that most physics and generally science/engineering problems are solved by constructing or selecting a model, from which the answer to the problem is extracted by model-based inference. In a profound sense the model provides the solution to the problem. Thus, an emphasis on models and modelling simplifies the problem of organizes a physics course into understandable units.

Inquiry Based Science Education (IBSE) has been proposed as a teaching and learning strategy that will not only increase the motivation and involvement of students and teachers in science studies, but one that will also develop high level cognitive skills.

Recent investigations have established the importance of metacognition in the acquisition and application of learning skills. (Panaoura, et al., 2009; Alexander et.al, 2003). Metacognition is associated with planning, monitoring, evaluating and repairing performance while metacognitive strategies guide students to think before, during, and after a problem solution. It begins by guiding students to plan for selecting the appropriate strategy to accomplish the task, and then continues as they select the most effective strategy and afterward evaluate their learning process and outcomes. Metacognitive strategies according to Piaget's cognitive development stages (1970) require abstract thinking that students become proficient in when they reach the formal operation stage (12 years and above). Although the concept metacognition has been defined in numerous ways, Sperling et al. (2004) suggest a focus on its component parts, which are self-appraisal, knowledge about cognition and regulation of cognition (Fernandez – Duque et al., 2000).

The aim of the article is to investigate the impact of the Computational experiment (CE), -Inquiry Based learning environments-developed using Easy Java Simulator(EJS) to: a) the learning performance b) the use of modelling construction indicators as suggested by Hestenes (1999), namely systemic structure, geometric structure, temporal structure and interaction structure and c) metacognitive skills through Inquiry Based Science Education(IBSE) environments that include the Computational Experiment as essential ICT tool. Forty, pre-service engineering students, participated in the research during the course "Pedagogical applications of ICT", implemented at ASPETE, as part of the regular undergraduate curriculum. Students were exposed to a number of computational experiments designed by the author, while during the course they developed their own computational applications. The results of the experiment show that Computational experiment (CE) favours the development of metacognitive skills and the use of the modelling indicators as it was evident by applications developed by the students.

Keywords: Inquiry Based Science Education, Computational Experiment

PS.02.10.S

Strand 2: Teaching Physics Concepts

Parallel Session 02.10 Symposium
Date & Time: 02.07.2012 / 13:00 - 14:30
Room: D506 (4th Floor)

Teaching and learning the concept of energy from early childhood school through university: PART I

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The learning and teaching of energy has been a rich field for research among students ranging in age from elementary school through university. Many proposals for how to teach the subject have been guided by this research. In a Symposium at GIREP 2008 in Cyprus, several researchers presented findings with implications for teaching energy concepts. One outcome of the Symposium was the conclusion that no clear consensus exists on the structure of a vertically integrated curriculum for teaching energy. A Workshop was held at GIREP 2010 with the goal of making progress toward the challenge outlined above, specifically to make progress toward a unified, research-based view of which energy topics should be taught at which educational level. Since that time a Topical Group on Energy was formed within GIREP. In this set of symposia, researchers from Greece, Italy, Germany, the United States, Israel, Portugal and the Netherlands will report on progress they have been making on the many problems associated with teaching and learning the concept of energy. Symposium speakers will describe their own investigations and place their findings within the context of the goals of the GIREP Working Group. Part I will focus on teaching energy to pupils in preschool and in primary school, as well as strategies for teacher formation. Part II will continue by examining the challenges of teaching the concept of energy to older pupils, in high school and university. Part III will focus on the engaging students in thinking about energy issues in their own lives and the historical development of the concepts.

Participants:

Part I: Teaching the concept of energy to preschool and primary school pupils and teachers
Stamatis Vokos
Department of Physics, Seattle Pacific University, USA
Dimitris Koliopoulos
Department of Educational Sciences and Early Childhood Education, University of Patras
Francesca Leto
University of Perugia, Faculty of Science for Formation, Italy
Marisa Michelini, Lorenzo Santi, and Alberto Stefanel
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Part II: Teaching the concept of energy to high school and university students
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Part III: Teaching specific aspects of the concept of energy from social, and historical perspectives
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Ugo Besson, Anna De Ambrosis and Pasquale Onorato
Department of Physics University of Pavia – Italy
Maria José BM de Almeida
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Matteo Leone (1) and Nadia Robotti (2)
(1) Educational Department, University of Torino, Italy
(2) Physics Department University of Genoa, Italy
Associated POSTERS
Paula R.L. Heron, Marisa Michelini, Bat-Sheva Eylon, Yaron Lehavi and Alberto Stefanel
Report of the Workshop in Girep Conference in France on Teaching about energy. Which concepts should be taught at which educational level?
Bat-Sheva Eylon, Yaron Lehavi, Position paper on energy teaching and learning
Federico Corni, Marisa Michelini, Lorenzo Santi
Report of the Workshop in Girep-Epec Conference in Finland on Teaching and Learning the energy concept and teacher formation in primary school
Yaron Lehavi,
Reproducing Joule's experiment(s)

Keywords: Energy Teaching Learning GIREP TGE

PS.03.01.a

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 03.01
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D402 (3rd Floor)

UNEDLabs: An Example of EJS Labs Integration Into Moodle

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Easy Java Simulations (EJS) is an authoring tool written in Java that helps to create interactive simulations in Java, mainly for teaching and learning purposes. By means of this tool, instructors can easily create virtual and/or (if they also use the appropriate additional software) remote laboratories. While virtual laboratories are based on mathematical models, remote ones use real equipment and so, the experiments are carried out in the reality.
Learning Management Systems (LMS) are software for web applications oriented for the administration, documentation, tracking, and reporting of e-learning programs. Moodle is a free source LMS with more than 57 million users, which makes it the most used LMS around the world. Like some other LMS, the stated philosophy of Moodle includes a constructivist and social constructionist approach to education, emphasizing that learners (and not just teachers) can contribute to the educational experience.
Virtual and remote laboratories (created with EJS, for example) as well as LMS (Moodle, for example) offer different but fundamental educational tools to both teachers and students. However, although these resources are complementary (and not mutually exclusive), the integration between them is still an open issue that must be addressed. Therefore, an e-learning program should offer both kinds of tools to be considered a complete experience for students.
UNEDLabs is a web portal that gathers together the two previous resources, offering an e-learning program based in: 1) experimentation (thanks to the use of the virtual and remote laboratories) and 2) theory documentation provision, social interactivity and easy management (thanks to the use of a LMS).
Nowadays, UNEDLabs offers two courses; one in Control Engineering and in the other one in Physics. Both of them offer three experiments which are available in the two possible versions: virtual and remote. The Physics course is still growing and new experiments are added every year. Right now, the three available ones are a motorized rotatory laser for studying the light in isotropic media, a motorized optical bench for determining the focal length of a thin lens, and an experiment with three springs related to Hooke's law.
Not only all the EJS laboratories in UNEDLabs are added and integrated into the Moodle web portal in a very easy and natural way, but they also acquire special functionalities they lack when used outside this LMS. One of these functionalities is the capability of saving and/or loading files to/from the private files repository in Moodle. Another one is the possibility to create collaborative experimental sessions with other users of Moodle who are enrolled to the course the EJS lab belongs to. Finally, EJS labs in Moodle can be administrated exactly in the same way as any other Moodle resource or activity, meaning they can be updated or deleted; their access can be restricted to a certain group of users or to users that have previously fulfilled some steps or conditions; security copies are automatically performed during Moodle's system backups, etc.

Keywords: Learning management systems, virtual and remote laboratories, multimedia, e-learning, physics

PS.03.01.b

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 03.01

Date & Time: 02.07.2012 / 14:40 - 16:10

Room: D402 (3rd Floor)

Understanding the effects of the light propagation through a 3D virtual environment: a first step to grasp the special relativity

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Aim of the study and rationale

This presentation will set out the results of an exploratory study aiming at appraising what the users of a virtual environment understand when they see macroscopic objects moving at speeds close to that of light c. The observation of effects explained in the framework of special relativity (SR) on mundane objects is impossible. Virtual reality (VR) enables to visualize those effects by means of a 3D immersive environment in which the speed of light can be reduced to usual values. Taking into account the difficulties usually encountered by students (Hewson, 1982; Scherr et al., 2001; Villani & Pacca, 1987; Author 2 et al., 2010) a learning scenario was designed and implemented in this environment in order to determine the way users reasoned about these effects.

Theoretical framework and research problem/question

In this scenario we focused on the concept of "event" as defined by its coordinates in space and time in a given reference frame. The perception of an event (e.g. emission of light) by an observer depends on the time taken by the light to travel from the location of the event to the eyes of the observer. Thus the signal travel time will impact the observations of the users immersed in the environment. In everyday life the light signal travel time does not matter because it is close to zero whatever the location of the emission of the event. But when the students take it into account, they consider that the order in which two events occur is a consequence of the order in which these two events are perceived as if causality would apply from future to past (Author 2 et al., 2010). In our environment the signal travel time cannot be neglected (c is fixed to 1m/s), thus mundane objects are not seen as in everyday life. The simulator we designed takes into account the relativistic effects (simulation algorithms based on Lorentz transform, Doat et al., 2011) and also those due to the light propagation. Then we make the hypothesis that the users of our simulator will take into account the time delay between emission and perception in a relevant way.

Methods and participants

The situation implemented in the simulator is a carom billiard in which two pucks move with velocities close to the speed of light (c is fixed to 1m/s). Five users were immersed in the simulator and had to explain what they saw when confronted to the following situations. The first one focuses on the instant of the impact of two pucks with a band. The second one pinpoints the apparent speed of the pucks. The third one concerns the shape of the pucks. Their explanations were audio-recorded and transcribed. We undertook a lexical analysis searching for some specific conceptual elements that we consider as key points for the users' understanding. These elements are the following: a) the incoming of light in the eye, b) the finite nature of the speed of light, c) the distance between the pucks and the user, d) the object discretization (a set of points as punctual sources of photons), e) the geometrical relativistic effects explained by the Lorentz transform. We searched the instants of their arising during the users' immersion in the environment.

Finding and results

By looking at the instants of emergence of the conceptual elements in the discourse of each user, we detected which situations favour the emergence of the conceptual elements that allow a relevant interpretation of the situation. Thus users were able to use firstly the conceptual elements a, b and c in phase 1 and then in the other phases again. They used the conceptual element d in phase 3. Lastly the conceptual element e was not used in any phase. These results indicate users need to be confronted to specific situations to use reasoning in which emission and reception of light must be described as punctual in space and time.

Conclusion and discussion

As a conclusion the immersion of users in the 3D environment where they are confronted to relativistic phenomena favours lines of reasoning that take into account the light travel time and the arrival of light into the users' eyes

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Keywords: 3D virtual environment, Special Relativity, physic learning, light propagation

PS.03.01.c

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 03.01

Date & Time: 02.07.2012 / 14:40 - 16:10

Room: D402 (3rd Floor)

Science at School at a Distance of a Click

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The field of science education is a continuous challenge to educators around the globe. New technologies, in this fast changing digital era, are opening the way to learning trajectories based in the use of real research methodologies. At the same time educators in schools around the world are fighting the lack of interest on the part of young generations. This fast growing gap between the available tools and resources and the demand of science knowledge on the part of students must be quickly addressed. Educators must be prepared to engage in a totally different approach for science teaching. A new era of tools, adapted to classroom curricula is emerging. Science empires are opening their database and producing user friendly interfaces to be used in schools.

In this presentation we will discuss the approach being adopted by the Discover the Cosmos consortium (an European Commission funded project) to engage students and teachers in research based science education. Participants find in this project a place to discuss their needs and limitation as well as an open dialogue space to share their vision and ideas. Members of different communities are gathering around Europe to design a new model for the road ahead. Facilities like CERN are contributing by making their repositories available to this mission. Robotic Telescopes are integrated in the proposed resources and exercises integrating the science method, while using new technologies, are a key part of this proposal.

The new era of education is clearly emerging where educators have to assume the role of tutors of this fast growing digitally skilled generation. The possibility of science discoveries are now at a distance of a click, students must assume this responsibility.

Keywords: astronomy, education, cern, discover the cosmos

Using Technology to promote student learning inside and outside the classroom

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For non-majors, introductory physics courses are often touted as some of the hardest college courses. The difficulty is partly due to the complexity of some of the abstract concepts covered in these courses and to the total number of concepts that are crammed into the curriculum. Research shows that promoting active learning (AL) can help make these courses more successful (Hake 1998). This project focuses on an AL method focusing on an extensive use of technology. The course follows a hybrid format where learning occurs both inside and outside of class. This format is similar to what is now labeled in some circles as the "flipped classroom" (Rundquist 2012.) Lectures are provided online in the form of lecture recordings. Class time is the used to work on problems, answer student questions, engage in hands-on activities, have students engage in discussions and sometimes explore related topics that students find interesting.

The genesis of the project arose from the interest students have shown in recordings of in-class lectures that the author had been providing in support of the courses he taught. (Liang et al., 2000. Mzoughi, 2003a, b). Students had access to a video recording of the computer screen used while the author lectured. They included videos, animations, interaction with simulations, static slides, cursor actions, and digital ink. Digital ink was generated whenever the author used a stylus to write over the PowerPoint slides on the Tablet PC screen he used. The audio included the sound generated by the computer software as well as the sound captured by the computer microphone. The quality of the sound was good only when the speaker was close to the microphone. Student questions were often inaudible. Students were able to navigate through the recording with the provided fast-forwarding and rewinding video viewing controls as well as an automatically generated table of contents.

In the current format students are provided with a list of short, concise concept recordings (CRs). Each of the CRs focuses only on one concept and might include simulations and videos as well as instruction. Some of the CRs focus on detailed, step by step solutions to example problems. The CRs are supplemented by online guiding quizzes (GQs). The GQs consist of simple questions designed to help students navigate and understand the content of the CRs. Furthermore, students are asked to submit a list of the concepts that they have recently learned as well as a list of the concepts they still find difficult. These are also submitted online as "Reflections".

Using an adaptation of the Just in Time Teaching (JITT) strategy (Novak, Patterson, Gavrin, Christian, 1999), the instructor reviews the results of the GQs, Homework (which is also submitted online) and Reflections before going to class. This review helps the instructor identify the areas that the students found difficult and plan the in-class time accordingly. The in-class activities can still include peer instruction strategies, interactive lecture demonstrations, ranking task questions, use of simulations, lecturing, in-class lecture recordings, and any method the instructor finds helpful in promoting student learning.

The paper will present details about the strategies used in this format as well as survey and anecdotal results from its implementation in several introductory physics courses.

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Rundquist, Andy, " What is the Best Use of Class Time? Exploring the Issues of the Flipped Classroom," 2012 Physics Teacher Education Coalition Conference: New Paradigms for Physics Teacher Education, February 3–4, 2012; Ontario, California (2012).

Keywords: hybrid, online, flipped, classroom, learning, outside, inside, concept recordings, guiding quizzes

PS.03.02.a

Strand 2: Teaching Physics Concepts

Parallel Session 03.02

Date & Time: 02.07.2012 / 14:40 - 16:10

Room: D403 (3rd Floor)

Analysing students' reasoning in electromagnetism

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Research shows that students' understanding of concepts from electricity and magnetism is often inadequate after standard instruction based on lectures. Students are often not enough engaged in activities that would allow them to construct deeper understanding of physics concepts. This approach may lead to deficiencies in students' knowledge structure. Many concepts are known to be difficult for students, and the concept of electromagnetic induction is considered one of the most difficult among them. The objective of this research was to investigate students' understanding and conceptual models of several electromagnetic phenomena, formed after standard lecture – based instruction in Croatian high schools. The investigated phenomena included magnetic fields around a steady current-carrying wire and inside coils, force on a current-carrying wire in a uniform magnetic field, electromagnetic induction and Lenz's law.

For the purpose of this research, a small number of Croatian high school students, aged 16-17, were interviewed after they had completed a course on electromagnetism. After having been shown a demonstrational experiment, students were asked to describe what they had observed and whether they could explain their observation. Each student was asked to think aloud, so that their reasoning could be analysed. Students were not corrected if they had arrived at the wrong conclusions. After they had formed their conclusion and stated that they had nothing to add, the interviewer gave them clues in form of additional experiments, as an attempt to create situations for students to test and revise their own ideas. The interviews were recorded with a video camera and transcribed for later analysis. Content analyses of the reasoning models constructed by these high school students showed a gap between the expected and the observed lines of reasoning. Students seem to have created their own incorrect models of electromagnetic phenomena, even though they had just successfully completed a course on it. They had difficulties in explaining how a magnetic needle works, or why it changes direction when put under a current-carrying wire, and needed to form their own new model of the phenomenon. They were able to regulate, re-evaluate and upgrade their model in a way an expert would do when given clues and asked questions.

This research suggests that standard instruction on electromagnetism may be insufficient for students to form a correct model of the phenomena and to achieve the right conceptual understanding. Teachers should be aware of students' incorrect reasoning patterns and try to correct them during teaching.

Keywords: electromagnetism, interview, student reasoning, reasoning model, content analysis

PS.03.02.b

Strand 2: Teaching Physics Concepts

Parallel Session 03.02
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D403 (3rd Floor)

Transmission of Sine Waves or of Pulses What is easier to understand? What is more adequate for the digital world?

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The topic "Wave Transmission" is traditionally treated in the frequency domain, starting with the harmonic oscillator and a system of coupled oscillators and leading to solutions of the wave equation and to Fourier analysis, where the latter allows to describe any kind of pulses as the sum of sine waves. The question is, how many students are able to understand and master these powerful and demanding mathematical tools and how many reach a deeper understanding of the underlying processes. Another question is, how many newcomers with a weaker mathematical background may feel overburdened and may give up, either switching to other areas of study of or even leaving the university.
Before the development of modern computers there were no alternatives to treat electric transmission processes but in frequency domain. With modern computers available, such processes, however, can be treated in time domain and this opens alternative approaches with an added didactical value.
Such an alternative has been developed in the form of program to simulate transmission processes based on a solution of the telegraph equations in time domain. All relevant line parameters are accessible for change, like frequency and form of the source, the form of single pulses, the impedance of the line and the resistance and capacitance of the load. The program allows to simulate and demonstrate a broad spectrum of situations and processes based on transmission, reflection and superpositions.
It visualizes transmission processes in mechanical systems (single tube and a closed circuit) serving as a preliminary stage for the main topic: transmission processes on an electric transmission line, where potential difference and current are indicated along the line in form a separate diagrams.
This program could support an introductory course before consideration in frequency domain with rather high mathematical demands are presented.

Keywords: waves, harmonic, transient, transmission line,

Strand 2: Teaching Physics Concepts

Parallel Session 03.02
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D403 (3rd Floor)

Magnetic field nature and magnetic flux changes in building formal thinking at secondary school level

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Despite the intrinsic importance of electromagnetism and its features in the curriculum in secondary school, there is still a lack of organic curricular proposals on it even if its learning difficulties were analyzed as individual learning problems: the concepts of field as a superposition (Viennot & Rainson, 1992), the field representation (Guisasola et all, 1999), the relation between magnetic field and electric currents, the nature of field itself (Thong and Gunstone, 2008), the sources of field and the role of relative motion in the electromagnetic induction (Maloney et all, 2001), the identification of the versus of the induced magnetic field (Bagno & Eylon, 1997).

To face these problems, the field lines were proposed as conceptual referent for the magnetic field representation, (Bradamante et al., 2005) but the limit of the field lines is that often they do not highlight the vectorial nature of the magnetic field as a property of space, related and distinct from other quantities that, as the force, also describe the interactions.

Context related exploration to identify anchoring concepts in a teaching learning path for the developing of interpretative formal models are in the background of a Design Based Research focused on a curricular proposal concerning the gradual construction of a coherent framework for electromagnetic induction that is aimed to founded the ground of the nature of the magnetic field and its properties as quantities of synthesis as the flux. The idea of flux had to be built not only on a formal level but also on the conceptual ones, becoming so a conceptual referent which changes over time produce the phenomena of electromagnetic induction; otherwise, induction will be only a phenomenon that occurs in correspondences of some actions losing its formal conceptual interpretation.

The focus of this research work was on the investigation of: RQ1) How did the students build the idea of field so that it could become an organic entity of reference; RQ2) When and how the concept of field become a conceptual referent in students' reasoning; RQ3) which is the role of the experimental exploration in building formal interpretative models of the electromagnetic induction.

Research based experimentation by means of inquired based learning path in which a gradual grow of the formal interpretative quantities was integrated with conceptual analysis of the quantities used for the interpretation of the phenomena. The experimentation of research was carried out by a researcher in two high school classroom at the presence of the school teachers, than, after a co-planning work with the researchers, was realized an action-research experimentation held by the teachers alone in one class. Al the classes involved are grade 13th (students are mainly 18 years old) and the classes are coming from different types of schools (one classical lyceum, one linguistic lyceum and one scientific technological lyceum). Data were collected by the written personal worksheets that student use as inquired based tutorial and through audio recording of the argumentative discussions.

Important results emerge from this experimentation at several levels. On the methodological plane: 1) criteria, instruments and methods of analysis of the properties of an entity as the magnetic field and its flux has descriptive and interpretative nature in the phenomenology of the electromagnetic induction, 2) design of pilot exploration on the properties of the formal entities involved in the phenomena, 3) the identification of the situations that produce the electromagnetic induction. On the plane of the construction of the formal thinking: 1) the connection between the field lines representation of the magnetic field and the properties of the magnetic field; 2) the flux of seen as a quantity which variation in time explain the phenomena of the electromagnetic induction. On the methodological plan are highlighted the inner path of coherence of the students' reasoning and the local process through which the mental models develop in global interpretative models and on the curricular plane emerge indications on the construction of differentiated learning paths going through the complex phenomenology of the electromagnetism.

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Keywords: Magnetic Field, Electromagnetic Induction, Construction Formal Thinking, high school students

PS.03.02.d

Strand 2: Teaching Physics Concepts

Parallel Session 03.02

Date & Time: 02.07.2012 / 14:40 - 16:10

Room: D403 (3rd Floor)

A semiquantitative treatment of surface charges in DC circuits

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The simple DC circuit is a basic content of every physics curriculum. One would think that any detail about this common system is known and well-understood. And yet, as several authors have pointed out, there is an important gap in the usual presentations of the subject. In the discussion of the Drude model, it is said -- usually without much comment -- that the electrons in a wire are guided by an electric field that is located inside the conductor and whose direction is parallel to the wire at any point. The origin of the electric field inside a long straight wire has been discussed first by Sommerfeld. He found that the field inside the conductor is generated by charges that are located at the surface of the wire. These charges are called surface charges.

Surface charges play a major role in DC circuits since they contribute in generating the electric field and potential distributions around the wire. Commonly, it is regarded as an extremely complex task to determine the surface charge distribution for all but the simplest geometries. It depends on the precise location of all parts of the circuit. There have been analytical solutions for special geometries and some rather vague qualitative rules. No general rule for the distribution of surface charges has been given up to now.

In the talk, we will develop a graphical method for the approximate construction of surface charge distributions in DC circuits. The method will allow us to approximately determine the location as well as the amount of surface charge for almost any circuit geometry. The accuracy of our semi-quantitative method is limited only by one's ability to draw equipotential lines. We illustrate the method with several examples. For students, the determination of surface charges via the construction of equipotential lines may be an opportunity to practice their corresponding skills. It may lead to a deeper understanding of the basic notions of electricity.

Keywords: physics, electricity, DC circuits, surface charges

PS.03.03.a
Strand 4: Laboratory Activities in Physics Education
Parallel Session 03.03
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D501 (4th Floor)

Analysing motion of falling magnet with video measurement tolls

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Analysing motion of a falling magnet with video measurement tools
The experiment with a neodymium magnet falling down inside a conducting copper tube is well known among physics educators as an example of Lenz's law and an interesting demonstration of interaction between magnetic fields of different sources. Sliding a ring neodymium magnet over a length of a conducting rod is an equivalent, from the physics point of view, to the dropping a neodymium magnet down inside a conducting metal tube, which have been recently investigated [1], [2]. The presentation shows an undergraduate laboratory experiment making use of video measurement tools to investigate motion of a ring magnet when moving over 1 meter long rods with different diameters made of aluminum or copper. To perform the activity the author used a number of neodymium magnets in a shape of 3,5 mm thick rings with outer diameter of 27,0 mm and inner diameter of 11,4 mm. The videos showing the process of sliding down were covered with ordinary video camera Fuji FinePix S5500 with a speed of 30 frames per second. The digital movies were analysed with the video measurement software Coach 6 and results were elaborated with spreadsheet Excel. Based on equivalent circuit approximation results [3] the author compares observation with a mathematical model of the phenomena. The process of setting up the experiment and the results of the measurements obtained within, as well as advantages and disadvantages of the apparatus are described. Possible didactical uses will also be introduced.
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Keywords: Lenz's law, video measurement tools, undergraduate laboratory

Personal touch with electric resistance

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In the primary school physical education the electricity is one of the topics that is abstract and often difficult to visualize. When introducing the concepts of resistance and conductivity to students - usually through Ohm's law - a resistor is used. Students check it by measuring the electrical current through and voltage on the resistor. Since resistor has a linear dependence of the current on the voltage, the resistor is one of the most used electronic elements in the school. Although it possesses suitable properties it is still an abstract or "black-box" element as students are not able to observe its properties directly. The concepts of resistance and conductivity as well as the electric currents in general are therefore often additionally illustrated with the hydraulic analogy. With ambition to bring the concept of resistance closer to students an alternative or supplementary device for visualization the effects of resistance is presented in this contribution.
A simple electronic device is a "detector" of resistance that can be introduced to school as a means of an experiential learning [1]. The simple electronic circuit composed of two NOT gates with Schmitt-trigger input, 2 LEDs, capacitor, resistor, some wires and 4,5 V battery students can produce by themselves and further on use it. The diodes in the detector alternatively emit light. The frequency of blinking LEDs depends on the resistance or conductivity in the circuit. Larger frequency indicates better conductivity. Since we are using the resistors in range between 200 and 500 kΩ -which are in range of resistance of human body - the students not only have the opportunity to experiment with different combinations of resistors, but also have the opportunity to become one. They can represent the resistor with their own body and even form series and parallel connections. The experiment can go even further, for example, they can also observe the influence of skin moisture on the conductivity.
Using this simple device many additional problems can be introduced. When students observe the influence of the skin moisture on the conductivity, they start to comprehend the basis of the devices such as lie detector, stress detector etc. If in the circuit a thermistor is used instead of a human body, the frequency of the light signal is changing when the temperature is changed. This method of encoding data is called frequency modulation (FM) which is widely used in communication technology.
The described electronic circuit is a device that can be used at different school levels from primary up to the higher education [2]. The examples of use preliminary tested among twenty 1st year physics students (future physics teachers) and eight primary school students of age 12-14 will be presented and discussed.
[1] Charles Platt, Make: Electronics Learning Trough Discovery, O'Reilly Media /Make, November 2009.
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Keywords: electricity, electronic circuit, human body as a resistor, experiental learning

PS.03.03.c
Strand 4: Laboratory Activities in Physics Education
Parallel Session 03.03
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D501 (4th Floor)

Experiments with a non-traditional charge indicator

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The purpose of this contribution is to provide classroom ideas for teaching electrostatics at high school and introductory university level. The experiments presented here use a simple low-cost device with three bipolar transistors that can detect charges in electrostatic experiments. Former version of such indicator was shortly presented at GIREP seminar several years ago [1], improved version and explanation of its behaviour is described in recent article [2]. It was checked at several occasions (see for example [3]) that teachers themselves can build the indicator in a short time and that they quite admire its simplicity and basic function. Apart from basic experiments that demonstrate the interaction at distance and determine the polarity of charged plastic and glass rods, the indicator can be very useful in a number of interesting experiments in teaching electrostatics. For example, it is possible to demonstrate how a person is charged after taking off a pullover (and how the pullover is charged in this case), find the polarity of charges when charging objects by electrophorus, demonstrate the charges of water drops in water drop electrostatic generator and even charging by ions produced by the air ionizer. These experiments will be discussed in the contribution. Also, some variants of the indicator will be discussed as well as the robustness of the indicator, which is an important issue for real use in classrooms. The other practically important characteristic of the indicator that will be mentioned is its sensitivity; it will be shortly described how it may be measured and analyzed theoretically at introductory university level.
The low price of all components (less than 0.5 USD in total) could make the indicator one of suitable tools for teaching about electricity in developing countries. Moreover, its simplicity, some interesting features and a range of applications can make it useful for physics classes, labs or some student projects also in other countries. Such possibilities will be also briefly discussed in the contribution.

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[3] Koudelková V, Faletič S. 2010 Teachers explore electronics. Phys. Educ. 45, 125

Keywords: electrostatics; low-cost experiments

PS.03.03.d

Strand 4: Laboratory Activities in Physics Education

Parallel Session 03.03

Date & Time: 02.07.2012 / 14:40 - 16:10

Room: D501 (4th Floor)

Nonlinear optical second harmonic generation as an advanced undergraduate experiment

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Second harmonic generation is the archetypal nonlinear optical phenomenon and occurs when a laser beam incident on certain transparent crystals is converted into another beam of double the frequency or half the wavelength. There are many other nonlinear optical processes including sum and difference frequency generation, higher order harmonic generation, four-wave mixing and optical phase conjugation, the optical Kerr effect, stimulated Brillouin scattering and stimulated Raman scattering, but second harmonic generation was the first to be demonstrated soon after the invention of the laser in 1960. It is also commercially important with frequency doubled infra-red lasers such as Nd:YAG being the usual sources of powerful visible light both continuous wave and pulsed. The design and operation of a wide range of existing and potential optical devices can also be understood in terms of the concepts of nonlinear optics including the optical parametric oscillator and white light continuum generation in optical fibres. Second harmonic generation makes an ideal experiment for an advanced undergraduate physics laboratory because it contains within it the important elements of nonlinear optics, i.e. the nonlinear dependence of the generated intensity on the incident laser's intensity, and the need for phase-matching in which the incident and generated beams travel with the same phase velocity. Unfortunately, illustrative examples are rarely found in undergraduate laboratories on account of the misplaced assumptions that the necessary equipment is expensive and that a high power laser is required along with attendant safety concerns. Surprisingly, second harmonic generation can easily be performed with milliwatt power He-Ne lasers or equivalent and home-grown crystals. In the University of Strathclyde's Department of Physics, the setup is provided in triplicate in recognition of its status as a core topic that all students should perform.

In this paper, the second harmonic generation experiment as performed in an undergraduate teaching laboratory is described and typical results presented to show its relevance to lectures in optics, laser physics and instrumentation. The topics covered are (a) the dependence of the second harmonic power (at 316.4 nm) on the fundamental power (at 632.8 m) as a demonstration of the nonlinearity of the phenomenon, (b) the dependence of the second harmonic power on the laser's propagation direction in the crystal in the vicinity of the phase-matching direction as an exercise in birefringence and refraction, and (c) the dependence of the second harmonic power on the laser beam's spot size in the crystal as an exercise in Gaussian beam optics. In performing the experiment, students also gain experience of handling and using lasers, photomultipliers, optical filters, oscilloscopes and amplifiers.

Keywords: laboratory experiment, nonlinear optics, second harmonic generation, crystals, lasers

PS.03.04.a

Satrand 11: Motivational Strategies and Metacognition

Parallel Session 03.04
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D404 (3rd Floor)

The Effects of Instructor Autonomy Support on the Quality of the Student Experience in Introductory Physics

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Theoretical Framework: We investigated the role of autonomy in the student experience in an undergraduate introductory physics course from a self-determination theory perspective. Self-determination theory comprises several mini-theories, including Basic Psychological Needs Theory which holds that autonomy is an intrinsic, universal need essential for the psychological health and well being of an individual and that motivates an individual (Deci & Ryan, 2002). Context and Research Questions: Black & Deci 2000 (hereafter BD00) investigated the role of instructor autonomy support on the student experience in a college level organic chemistry course, where instructor autonomy support means taking the student's perspective, acknowledging the student's feelings, and providing the student with opportunities for choice. This study builds on that of BD00 by performing an independent check of their results within the context of an active-engagement introductory physics course. Specifically we tested the hypotheses that instructor autonomy-support as perceived by the students correlates positively with performance, increases in autonomous reasons for studying physics, and adjustment (i.e., increases in interest and confidence and decreases in anxiety). We then move beyond BD00 by performing a controlled experiment to investigate the effects of increasing the number of in-class choices and options provided to the students through the course format.
METHODS: This study was carried out in a 330-student introductory physics course for undergraduates in the biological sciences at the University of California, Davis. Students, in this course, attend one 80-minute lecture and two 140-minute discussion/labs each week. The 30 students in each discussion/lab work in small groups at group chalkboards. Group work is interspersed with student presentations of their work and brief whole class discussions are led by the discussion/lab instructor.

We measured instructor autonomy support, as perceived by the students, with a questionnaire completed by the students at the end of the course. We measured student performance with quizzes and exams. We measured student adjustment and changes in autonomous reasons for taking physics with questionnaires completed at the beginning and end of the quarter. We tested for the dependence of instructor autonomy support on performance, adjustment, and changes in autonomous reasons for taking physics.

We also investigated the effects of autonomy built into the course format. We compared a control group of discussion/labs in which students worked through a series of activities to a treatment group of discussion/labs in which the second half of each class was open to the students to choose how to apply covered concepts. Students in the treatment group were provided with various options but were also encouraged to come up with their own applications of the concepts of interest to them.
FINDINGS: We found that students who perceive their instructors to be more autonomy supportive tend to adjust better to the course (i.e., become more interested and confident and less anxious) and develop more autonomous reasons for studying physics. Instructor autonomy support does not, however, correlate with performance. We found from the controlled experiment that increased opportunities for choice built into the course format did not lead to significantly different performance, adjustment, or changes in autonomous reasons for studying physics.
DISCUSSION and CONCLUSION: The majority of the BD00 results from a course in organic chemistry carry over to the active-engagement introductory physics course of this study, suggesting that these findings are not highly dependent on content. Also, whereas instructor autonomy support as perceived by the students did not play a significant role in student performance, it is significantly correlated with the overall quality of a student's experience. The finding that high autonomy support is correlated with more positive student feelings (e.g., higher confidence, lower anxiety) suggests that teaching methods that provide high levels of instructor autonomy support may be preferable.

We conclude from the controlled experiment that the number of opportunities for choice built into the course format plays a far less important role in the student experience than the level of autonomy-support students perceive from their instructors. Also, while providing students with more choices as to how to spend their class time did not improve their performance, it did not hurt it either, suggesting that students are capable of making sensible decisions regarding the activities that lead to their own learning in this environment.

Keywords: Autonomy, Motivation, Interest, Confidence

PS.03.04.b

Satrand 11: Motivational Strategies and Metacognition

Parallel Session 03.04
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D404 (3rd Floor)

A Literature Review of Affective Variables in Physics Education: What Are The Affective Needs of Learners?

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The cyclopedic education dictionary (1998) defines affective domain as "an area of learning that concerns itself with feelings, beliefs, and values." In last decades affective domain in science education has been given more importance because of not only its links with cognition but also of alarming situation of students' low attitudes towards science learning that results in decreasing choice of science career. Moreover, some educators argue that long term outcomes of an education process -affective changes- are a more important goal of education than cognitive changes. Obviously providing students with better motivation in science is an important point for training innovations making scientist, engineers, and doctors in the future.
Affective domain related researches in physics education are not so common when compared with other science branches (Güngor, Eryılmaz and Fakıoğlu, 2007). However, affective aspects of physics learning is a big barrier for learners since literature supports that physics is not popular and negative affective variables affects students' both success and career choice in physics. Researches (Kubli; Lehrke; Lehrke, Hoffmann, & Gardner; Dengler; Rosenthal as cited in Fischer and Horstendahl, 1997) revealed that physics is one the less liked subjects. And, high school students reported that they attribute their failure in physics mostly to not loving physics and not having aptitude for achieving physics (Kahyaoğlu & Şimşek, 2010). Furthermore, the common views of secondary school students about physics are that physics is 'difficult', 'irrelevant' and 'boring' (Williams et.al., 2003). Those findings imply us that not only the cognitive aspects but also the affective aspects of physics instruction should be considered and defined and in continuation the corresponding needs should be tried to be meet by educators.
Purpose of this study was to make a literature review about the affective variables in physics education and prepare a paper of compiled results which gives implications to educators about what are the students' affective needs while learning physics. Major affective variables such as attitudes, interest, motivation, self efficacy beliefs, goal orientations defined by literature were chosen as key words for this study. The combinations of these key words with physics learning/instruction/teaching were searched within International Dissertation Abstracts, Social Science Citation Index (SSCI), Educational Resources Information Center (ERIC), Ebcohost, and with Google search engine, Internet. The achieved literature was studied to compile general results and implications about general status of students' affective characteristics and their affective needs while learning physics. By this way researchers would consider how a physics instruction should be to meet students' affective needs.
Literature review revealed that although motivation in physics is likely to increase physics achievement of students we have problems about this issue. Students have more negative attitudes towards and less interest in physics as the grade level increases and possible reasons of this situation are asserted as irrelevancy of physics and low value related expectations. On the other hand, literature review on affective variables in physics learning has shown some common points to be considered while designing a physics instruction. It was found that social interaction, students' being active in class and establishing relevancy of content are suggested solutions to provide better motivational results in a physics instruction. Therefore, we can conclude that learners need a motivationally supported physics instruction that brings together their active involvement, their social interaction and making experiments.
Physics is one of the lessons which need students' motivation providence most due to students' common negative affective characteristics about it. Moreover, affective characteristics of students towards learning physics might add many values to their learning process different from merely achievement. Therefore this review would help researchers to see which affective variables would be taken into consideration while designing an effective physics instruction.

Keywords: Affective Variables, Motivation, Physics Education

The need to encourage FET Natural Science Teaching Profession students at university to study Physics as a major

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Students at tertiary level have not been up to scratch with Physics learning hence the all time poor or low number of Physics graduates in general. Universities are of course producing graduates in Natural Science and related fields including for the teaching profession but majority of them did not specialize in Physics. When we look at Further Education and Training (FET) or High School curriculum or syllabus, we find that Physical Science composed of Physics and Chemistry of equal weighting in final assessment, divided into two separate papers written at separate times, is one of the subjects.
Most teachers are comfortable with chemistry and as a result Physics section suffers. Students at matriculation or Grade 12 level end up not doing well in Physical Science in general due to poor performance in Physics and hence their results in this subject have been all time low. This has been a syndrome that has purported students not to be interested in careers in Science and ultimately more specifically in careers or courses or programmes in or involving Physics including teaching. Most students at university will study Physics at First year level because it is a prerequisite for other majors or is compulsory at first year.
As a result they end up doing it for the sake of passing it in order for them to be able to able to do their majors or just to pass it, i.e. it is compulsory subject in the form of ancillary subject or module and or it is a prerequisite to other subjects or courses of their choice. They end up lacking or not having conceptual understanding and knowledge of it. The majority of students cannot even notice or recognize the application or use in their learning fields or courses.
This paper seeks to investigate possible ways by which if Physics is studied at university, the country will not be faced with a crisis of Physical Science teaching in schools with particular reference to Physics. The teaching of Physical Science suffer and the resulting low results at matriculation or Grade 12 and most probably from the lower Grades is due to the phobia educators have with the teaching of Physics section, which comprises 50 % of the student’s mark in his or final Physical Science mark.
If these, the possible ways to stimulate the study and teaching of Physics from high even primary or middle school to tertiary level are designed, implemented and practiced properly students studying towards Physics careers will increase tremendously. The integration of both methodology and content teaching and learning in Physics will enhance the pass rate in Physical Science at high schools which will be escalated in Science in general, Engineering and Technology Fields or studies at tertiary level or university. Science teachers in schools just need that motivation and confidence to teach the subject at ease. With this knowledge and skills in Physics imparted well at schools, the country will not be marginalised in terms of shortage of scarce skills careers.

Keywords: Specialise in Physics, Matric Physical Science, Science Teaching conceptual understanding and knowledge, integrate, methodology, scarce, skills, motivation, confidence, escalate, ease, high schools, curriculum, syllabus

PS.03.04.d

Satrand 11: Motivational Strategies and Metacognition

Parallel Session 03.04
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D404 (3rd Floor)

Fostering better engagement among male and female students in the physics laboratory

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Teachers observe it every day and research shows it more and more clearly: male and female students engage differently in their studies and in class. Since, in general, female students respond more easily to academic requirements in a traditional learning context, we wanted to see if a new approach in the physics laboratory would have a favourable impact on the engagement of both genders, and in particular on male students.
Within the scope of a research project conducted at Collège Shawinigan over a two-year period, we studied the impact of two types of experiments in the physics laboratory on the engagement of students in the Natural Science program: traditional closed experiments in which the process is directive and defined by the teacher; and open experiments in which students participate more actively in the different stages of the activity.
Our results suggest that both gender present better engagement with open experiments. We will discuss that even if female students get better grades in open experiments, boys are the ones to be more cognitively engaged. Also, we will propose a general model of cognitive engagement in physics laboratory.

Keywords: Physics laboratory, cognitive engagement, gender, open experiments

PS.03.05.a
Strand 3: Learning Physics Concepts
Parallel Session 03.05
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D406 (3rd Floor)

Context-based physics education and learning with newspaper based and other authentic learning problems: An empirical study

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Context-base physics learning (CBPL) has a long-standing tradition and is considered as a highly promising approach in current physics (and more generally, science) education. Drawing on good practice reports from teaching approaches in physics and neighboring subject matters [1], as well as on science education research [2], [3], the present contribution investigated learning with physics tasks and problems based on newspaper articles and the real-life contexts provided by them. The positive effects reported for CBPL are, among others, that it fosters motivation and learning in general, and some specific components of these in particular, such as authenticity of otherwise "dry" subject matters, and transfer of acquired knowledge.
With this background, the rationale of the present work is twofold, viz. an approach taking advantage, on the one hand, of the educational potential of context-based science learning by using, on the other hand, easy-to-have, and easy-to-adapt learning materials, such as newspaper based physic problems (thus facilitating classroom implementation). The ensuing research questions are, whether the above-mentioned general motivational and learning benefits and several important components (among others, on authenticity and transfer) actually can be found and moreover, whether such potentially positive effects can be established for more than short-term duration and for a broader selection of learners and learning conditions.
In the presentation, the general research background of CBPE is explained more in detail for some important features of the present work, such as the particular role of story contexts (see e.g. [4], [5]), and a set of specific design principles inspired by the instructional approach of "Anchored Instruction" [6]. Subsequently, materials and methods of the investigation are described (quasi-experimental repeated measures design, instruments, validity controls). In particular, instrument choice (from existing, well established instruments e.g. [7] for physics motivation) and instrument development will be discussed, including validity and reliability measures (satisfactory values for interrater agreement (Cohen Kappa) on curricular validity of learning and test material and Cronbach alpha for reliability of all motivation and learning scales were obtained throughout).
Results are presented for several essential concepts of physics, based on a comparison ($N = 911$) of experimental classes (with newspaper story problems) with control classes (with conventional exercises, but otherwise the same lesson plan, and the same teacher); for details see [8]. There is a significant improvement of motivation ($p < 0.05$ in all cases), representing a large effect size (Cohen d up to 1.66). The same holds for learning including transfer ($p < 0.05$ in all cases, $d = 0.9$ and larger.) These effects were shown to be rather sustainable (similar results after at least two months).
These findings, together with their "classroom usability", allow to conclude that newspaper story problems represent a promising form of context-base physics learning. Practical implications and possible limitations of this conclusion will be discussed, such as possibly small, narrow, and short term effects only (shown not to occur), and effects on higher order competences, such as problem solving. As an outlook, research implications and possible generalisations of the present research framework will be discussed, such as to other competences (as just mentioned), to other types of authentic learning media (e.g. advertisement problems), and to other subject matters.

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Keywords: context based science learning, motivation, authenticity, transfer, newspaper story problems

PS.03.05.b

Strand 2: Teaching Physics Concepts

Parallel Session 03.05

Date & Time: 02.07.2012 / 14:40 - 16:10

Room: D406 (3rd Floor)

The importance of teachers' questions in inquiry-based physics classes: building categories based on references of the area

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Teachers' questions are among the elements of classroom discourse dynamics featured in current research on language and science learning. Mortimer and Scott (2002) point to the importance of teachers organizing the teaching "rhythm" in the classroom, associating discursive variations in these situations. Such intentions are divided into 1) creating a problem, 2) exploring the students' views, 3) introducing and developing the scientific story, 4) guiding the students in their process of internalizing scientific ideas, 5) guiding students in the application and increased use of scientific ideas and 6) upholding development of the 'scientific story'. We will incorporate this enunciative sense of intention in the categories of questions for inquiry-based physics classes.

Another point, present in summarizing the meaning of the categories proposed is the profile/type of class we believe to be productive in terms of learning physics. What we refer to is inquiry-based classes in which the students solve a problem. We consider this inquiry-based outlook as being circumscribed to science teaching by means of scientific literacy, i.e., teaching based on a curriculum that leads students to think about a problem, create strategies and an action plan to solve it, and organize information and knowledge – new or already acquired – that will enable them to explain phenomena (Sasseron and Carvalho, 2008). Therefore, what we propose is a classification for teachers' questions in inquiry-based physics classes that will facilitate students' understanding of the functions and uses of science thanks to the intentions implicit in the teacher's questions. To this end we used the argumentation cycle proposed by Sasseron and Carvalho (2008) which has shown that students find an argumentation pathway when developing an inquiry activity. Along this pathway students: 1) observe data; 2) define variables; 3) create and refute hypotheses; 4) draw up justifications, 5) forecasts, and 6) explanations.

Finally, we sought three different studies (Penick, apud Clough 2007; Martens, 1999; and Exploratorium, 1996) whose research topics featured classifying types of questions for different science-teaching strategies. However, we sought to draw up a classification that would be applicable for use as a discourse-analysis tool in which intentions inherent to the interrogative utterances help students by encouraging them in their investigation process and in the development of argumentation skills that lead to scientific literacy.

Therefore, when relating the categories of teachers' intentions to stages of the students' argumentation cycle, we see that they point to a close relationship between what the teacher asks and the students' discursive replies.

Speculation regarding students' previous knowledge and the intention inherent to creating a problem appear as a particular moment prior to dealing with the data. The inquiry process is part of an intermediary moment of contact close to what the students know given the limits of their knowledge in collective participation. And, a third moment extrapolates that knowledge to another context outside of which it was meant. Based on these movements, we proposed four categories that can summarize and serve as an analytic base to observe discursive interactions in inquiry-based classes. The categories are listed below:

Problematization Questions: the questions refer to the actual problem under study or are implicit to that problem within the proposed inquiry. Problematization reorganizes, reformulates in another way, and returns to the proposal of the problem. Problematization questions help students to plan and to seek solutions to the problem. They also explore what knowledge students had prior to solving the problem. They feature the problem's demands and enable students to organize the information needed to solve that problem.

Questions regarding data address the data involved in the problem by showing or introducing them, or by selecting them or discarding the non-variables. They guide students' eyes to the variables involved, relating them, seeking a higher degree of precision, comparing ideas, proposing reversions or changes.

Exploratory questions/process – The aim of exploratory questions/processes is to lead students to draw their own conclusions regarding the phenomena. This may require students to draw up hypotheses, rationalize, explain, and reach conclusions as means of systematizing their thoughts prior to voicing their own opinion. Exploratory questions/processes aim to fix in students' minds that which was learned from the proposed situation, to lead them to think about the subject and construct a model to explain the phenomenon being studied, as well as making them review the process whereby they solved the problem, clarifying the steps taken.

Questions regarding application seek to lead students to apply the concept grasped in other contexts and to foresee explanations for situations other than that presented by the problem.

Comments on the classification

In this theoretic analysis we noted a similarity between the discursive paths of an inquiry class from the viewpoint of scientific literacy, and the intentions inherent to the teacher's utterances within the genres of discourse represented in the class. Drawing up a new classification of questions enables us to pinpoint an analytical object for this type of class, offering indisputable relations between the process of lending meaning to scientific concepts and the discursive route adopted by teachers in their classes.

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Keywords: Questions, interative discourse

PS.03.05.c

Strand 2: Teaching Physics Concepts

Parallel Session 03.05
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D406 (3rd Floor)

Actions and Strategies Elementary School Teachers use to Foster Argumentation and Scientific Literacy in Inquiry-Based Classes

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Our object here is to analyze classroom work aimed at fostering the development of scientific literacy (SL) and argumentation among students. To this end, two different teachers in two different schools applied the same investigative teaching sequence to 9- and10-year-old 4th grade elementary school students. We focused two classes featuring the same activities in each of the two schools using teacher fostered scientific literacy and argumentation based theoretic references. This allowed us to analyze the teacher’s pro-argumentation actions as well as the process of scientific literacy development among the students. Our initial analyses focused on studying student-teacher interactions and identifying scientific literacy indicators in the course of those interactions. We then analyzed the argumentation-related teaching strategies that the teachers used when proposing activities and discussion. The results allowed us to compare the performance of the two teachers in a situation of methodological innovation as well as the results that each achieved. We noted that the students of school 1 expressed scientific literacy indicators more often and more consistently as compared to those of school 2. In both schools, the teacher’s actions aimed at fostering student participation and work with data. Also in both schools, the central topic of the classes was made clear and the discussions allowed us to state that the central argument under discussion was constructed. The teachers’ actions led to the differences in results obtained from the two situations. The teacher of school 1 resorts much more to the students’ construction and use of rationales, constantly leading them to assess the situations they study – a strategy that favors the construction of more complete explanations – while the teacher of school 2 develops work that leads most students simply to list the information they obtained. In our opinion, the strategies employed by the teacher of school 1 led the students of that school to use a greater number of scientific literacy indicators as compared to those expressed by the students of school 2. That difference in the number of scientific literacy indicators seems to be associated with the fact that the students of school 1 feel compelled to express their ideas logically using the available data and constructing relations among those data, while the students of school 2 feel that describing life experiences or actions carried out is sufficient. We can thus conclude that teachers’ actions are essential in fostering argumentation among the students. The teachers’ actions not only encourage student participation, they lead the students themselves to determine the degree of logic and complexity involved in their understanding and construction of knowledge.

Keywords: Scientific literacy, Teachers' actions, Elementary school

Teacher education in the context of modern and contemporary physics: an experience with public system teachers

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The need for Physics curricular reformulation in High School has becoming more and more evident when is realized the importance of discussing problems and social issues that cut across new technologies created by scientific development, which contribute to an effective scientific literacy. From this perspective, the Modern and Contemporary Physics insertion (MCP) can contribute to some curriculum change, leading more current content through new methodologies for classroom. But in this process various obstacles are highlighted by research, such as, the teaching education (Davis, 2003; Siqueira, 2006). Teachers play an important role in the context of curricular innovations, because they bring the new proposals to their classroom. However, some innovative proposals do not consider relevant the role of these professionals, ignoring their beliefs and value, which can be source of obstacles to the innovation implementation. Inserting teachers into research groups, which work under an innovation perspective can be one way to reduce these problems (Carvalho, 2004), thus, not only they will have opportunities to discuss new materials and teaching strategies, but also they will bear the riscs and transform their practice (Couso, 2009). In this sense, we investigated four teachers from public school who participate in a research group, which focus on the insertion of MCP, highlightening both those relevants aspects from their participation and also the role of the group itself in this context. For this reason we used a semi-strutured interview, which aimed at raising their perceptions about their own participation and the constitution of the group in the MCP insertion, as well as their difficulties and obstacles faced during the implementation. As a result of this interview we drew up three categories of analysis. Moreover, from their report, it was revealed the key role that the group has for the implementation of FMC, because it becomes a place of support, as can be seen in the speech of a teacher "If you have a question, once you bring to the group, many people are thinking. "The factor is a group, everyone working on that thing [...] led to work with the FM in peace." Furthermore, it was noted that after a while the group manages itself and that teachers naturally end up seeking an improvement in training through post-graduate students feel that they can contribute more if they participate actively in research, reflecting well in their professional development.

Keywords: Curricular Reformulation; Modern and Contemporary Physics (MCP); Teacher Education.

PS.03.06.a

Strand 4: Laboratory Activities in Physics Education

Parallel Session 03.06

Date & Time: 02.07.2012 / 14:40 - 16:10

Room: D405 (3rd Floor)

The Expo-Laboratory "The sound of the Earth, tools, games, harmonies and rhythms" - an original and effective inquiry approach to discover the magic of the waves

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The Department of Education of the Aosta Valley, Italy, organizes every year, through the Office of Science education, an educational project, particularly original and effective, called Expo-Laboratory, combining exhibits and scientific demonstrations with hands-on activities, with increasing knowledge and complexity.
The aim is to improve the interest towards science, particularly through the use of practical instruments and tools, in an inquiry approach, involving the largest number of students.
As the Aosta Valley is a mountain region with schools all across the territory, the logistic is an important factor of success: we have chosen a travelling lab in order to promote the participation of classes, packing all the materials and setting up the exhibitions in different places, schools or public libraries.
Every year a topic is selected in order to promote cross-fertilization between various scientific and non-scientific disciplines: biodiversity, year of the Earth, proposed by the international community, or others linked to events of the year.
This year of tsunamis and earthquakes have suggested the waves as main subject: the topic is "The sound of the Earth, tools, games, harmonies and rhythms, discovering the magic of the waves" and it has been realized with the help of the Association of Physics Teachers- Valle d'Aosta and of music teachers.
The educational path runs across physics, earth science, biology and music, using tools coming from the Regional science centre and from schools' laboratories: old and new instruments and tools, often forgotten, poorly known and rarely used are organized in a structured learning path.
Through installations, exhibits and interactive workshops, of high technical level as well as handcrafted objects, scientific subjects and used instruments are made available to all teachers and to students of all ages.
The different stations are proposed by students of higher schools to the visiting public in a peer education approach: students-mediators must be able to propose each topic with the correct scientific language, making it understandable to public of different age, when we deal with schools, or quality, if we consider other visitors.
They explain how the waves propagate in different physical means, but also in vacuum and the laws governing their transmission, reflection, refraction and diffraction, in relation to the various types, longitudinal and transverse, mechanical and electromagnetic, seismic, acoustic and optical, long and microwaves. Each effect, noise pollution and Doppler effect, prevention of earthquakes or the structure of the ear, are well explained.
But they must be able also to propose an inquiry approach, not in a "talk and chalk" lesson, but through an interactive and engaging pattern.
Part of the Expo-Laboratory is devoted to the transition from sound to rhythm, and to music, analysing amplitude, frequency and shape of the waves. Different types of musical instruments, professional or playful, allows students to understand the relationship existing between sounds, deep or acute, and materials.
The Chladni plate allows to visitors to understand symmetries, Theremin enables to "see" acoustic waves, the ripple tank to explore the geometry of waves, the Chinese bowl to recognise nodes and ridges.
The experience gained over the years confirms the validity of the use of peer education to illustrate and to mediate the contents and to animate workshops and exhibits: the number of the visiting classes is increasing over the years: new educational tools are "discovered" and experimented by teachers and the following year they become of "common use", while scientific arguments rarely developed become part of the ordinary school curriculum.
Through this journey teachers will find out unexpected connections between educational subjects, only apparently distant from each other but in fact closely linked in a scientific educational network; at the same time students will discover the "magic of the waves".

Keywords: Expo-laboratory,waves, inquiry approach

PS.03.06.b

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 03.06
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D405 (3rd Floor)

Discover the COSMOS: e-Infrastructures for an Engaging Science Classroom

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The Discover the COSMOS (DtC) is a Coordination Action project (2011-2013) funded by the European Commission's Framework Programme 7 and composed of 15 universities, research institutes and centres in eight European countries and the USA. Its overall purpose is to demonstrate innovative ways to engage teachers and students in eScience through the utilisation of existing e-Infrastructures in order to help reverse the declining student interest in science and in following scientific careers. Situated within current re-schooling initiatives in Europe (Rocard et al, 2007) and beyond (OECD, 2006), the project aims to support policy development for the realisation of the vision for the science classroom of tomorrow by: a) demonstrating effective community building between researchers, teachers and students and empowering the latter to use, share and exploit the collective power of unique scientific resources (research facilities, scientific instruments, advanced ICT tools, simulation and visualization applications and scientific databases) in meaningful educational activities, that promote inquiry-based learning and appreciation of how science works, (b) demonstrating effective integration of science education with e-infrastructures through a monitored-for-impact use of e-Science activities, which will provide feedback for the take-up of such interventions at large scale in Europe and documenting the whole process through the development of a roadmap that will include guidelines for the design and implementation of effective educational and outreach activities that could act as a reference to be adapted for stakeholders in both scientific research outreach and science education policy.

Tapping into expertise from frontier research scientific and educational research in formal and informal science learning, the Discover the COSMOS initiative acts as a vehicle through which Europe's e-infrastructures can be exploited fully by providing in an integrated way powerful tools for the effective introduction of e-Science initiatives in the school science curriculum framed in a pedagogical approach that promotes inquiry-based teaching and learning. In doing so, it creates a rich repertoire of e-Science applications that enable secondary school students to experiment with, appreciate and learn how cutting-edge science works by 'entering' the world of:

- Particle and high energy physics (HEP) infrastructures at the European Organisation for Nuclear Research (CERN) including the Large Hadron Collider (LHC) and its dedicated experiments ATLAS and CMS;
- Astronomical infrastructures including the Gaia global space astrometry mission, the Faulkes Telescope Project and the Liverpool Telescope.

The Discover the COSMOS consortium brings together key players in the field of HEP and astronomy outreach that have invested major efforts over the recent years to introduce frontier research issues into the science school classrooms in Europe and beyond. The e-Science applications included in the framework of Discover the COSMOS' educational activities enhance the effectiveness and quality of the teaching and learning process by employing advanced and highly interactive visualization technologies that offer a 'feel and interact' user experience, allow for learning 'anytime, anywhere' and provide personalised ubiquitous learning paradigms. They have also been tested in different educational settings (schools, teacher training centres, outreach programmes, workshops, and summer schools) in Europe and beyond and have proven their efficiency and efficacy as inquiry based resources.

Keywords: e-Science, Inquiry-based Science Education, Engaging Science Classroom, Effective Outreach Programmes, Pool Talent in Science

PS.03.06.c

Strand 6: Secondary School Physics

Parallel Session 03.06
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D405 (3rd Floor)

Using Common Formative Assessments with Middle/High School Students to Inform Pedagogical Approaches for Teaching Scientific Content

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In the United States, science standards for kindergarten through twelfth grade are being reformed at state and national levels. As a result, it is becoming increasingly important to conduct real-time research to inform teaching strategies. As stated by A Framework for K-12 Science Education, which is currently being used to construct new national-level standards, the United States is falling behind other countries and its own past achievements in science education; it is imperative that approaches to teaching science are not only engaging, but also provide the necessary foundations to create a future workforce informed to solve humanity's current and future challenges. Formative assessments can allow teachers to immediately understand what is and is not working in their classrooms for the purpose of changing how they teach various content. Many school administrators do not understand the difference between summative and formative assessment and actively prevent true formative assessment to occur. The teachers then proceed to "give them what they want" with no useful effect. This study presents a model, as well as its application, for the development of formative assessments in the classroom in a rurally located, city high-needs district in the state of Ohio. The authors wrote formative assessments (CFAs) for the teachers in seven categories: sixth grade, seventh grade, and eighth grade for the middle school, and physical science, biology, environmental science, and physics for the high school. Teachers had the opportunity to provide feedback, the CFAs were changed if necessary, and then they analyzed the CFA at the both the beginning and the end of the quarter. The emphasis in the analysis was on what student thinking as expressed in writing reveals. The pretests reveal what students think at the beginning, giving the teacher an idea of what ideas might already exist, right or wrong; the posttest should reveal to the teacher whether the instruction succeeded. Results indicate changes not only in the way teachers view their pedagogical approaches, but also in how teachers consider student personal epistemologies.

Keywords: science standards, formative assessment, modeling

Students' conceptions of gravity and gravitation

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Textbooks often use the terms, gravity and gravitation, interchangeably. For example, phrases such as acceleration due to gravity and universal law of gravitation, implicitly portray that the key word used is somewhat different. In other words, whilst gravitation is perceived to be the force of attraction between two objects, gravity is perceived to be the pull of a celestial body on an object in it. A study was conducted on Grade 12 (N=180) students to elicit students' understanding and conception of the two terms. They were asked to explain their understanding of these two terms. The responses to these two questions were then analyzed using the grounded theory approach. The students' responses to each of these questions were classified into the various categories which emerged from the analysis of the data. The different categories which emerged were then checked by two experienced physics teachers. They were in broad agreement with the classification of the categories. Cohen's kappa and inter-rater reliability for the categories were determined as well. Results showed that a significant number of students view the two terms differently while others think they are similar. Cross-over variations of the definitions were also encountered. The variation in the responses of the students to the two terms can be traced to how textbooks portray these concepts and also how they are taught in class. Some suggestions for resolving these differences are suggested as well as implications for teaching.

Keywords: gravity, gravitation, Cohen's kappa, inter-rater reliability, grounded theory

PS.03.07.W

Strand 4: Laboratory Activities in Physics Education

Parallel Session 03.07 Workshop
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D502 (4th Floor)

The inclusion of environmental issues is an important component of science education; we developed the course for science teachers, the goal was to improve the quality of learning of climate by laboratory activities

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Physics based on experimental observations, and learning how to perform and design experiments effectively is an essential part of physics education. Environmental physics is an ideal interdisciplinary theme for lifelong learning about the scientific process and the ways in which humans affect and are affected by the Earth's systems.
We presented here our stand-alone modul of laboratory activities that provides personal experience with environmental and ecology phenomena.
We tried to compile appropriate activities which can be effective in helping students to construct their environmental physics knowledge as well as problem-solving abilities.
Our laboratory course was designed not only for students needing an introduction to scientific methods but in addition it allows training in laboratory techniques on research instrumentation for physics.
Several experiments in lab-modul are designed outdoor that are assumed to promote students interest in natural environment.
We hope that at the end of this course student will have developed a basic understanding of the following: Solar influences and heating, Earth's energy budget, Characterization of in the atmosphere, temperature variation, Moisture and the role of water in stability considerations, The climate system, variability, The atmospheric issues related to global change.
As a assessment tool we implemented student portfolio. Portfolio is set of reports produced by the groups of students who work on the inquiry activities. These reports provide a valid source of information about the students observations, data, questions asked, as well as suggested hypothesis and plans for further experimentation.
The preliminary course consist of the following activities:
1 Measurement of carbon dioxide and sunlight
2 Measurement of conditions of evaporation.
3 Measurements and calculation of solar irradiation
4 Greenhouse effect demonstration
5 Demonstation of pyrolysis and production of biocarbon
6 Measurement of different surfaces albedo
7 Measurement of atmospheric aerosols and cloud properties
8 Measurement of properties of the atmosphere

Keywords: science literacy, environmental physics

PS.03.08.W
Strand 6: Secondary School Physics
Parallel Session 03.08 Workshop
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D504 (4th Floor)

Environmental Physics

David Gewanter
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Deepen the environmental impact of your physics teaching.

The presenter will share successful curriculum strategies and materials developed for both brick and mortar schools and a blended online environment.
Exploring the physics underlying geology, astronomy, meteorology, and oceanography, students in this course examine the universe and their place in it. Collaboratively, students identify the social, personal, political, and economic implications of various problems and solutions, pursuing such questions as "What can I do to make a difference now?" and "How might what we know about the earth affect our treatment of our planet?" As students gain experience and deepen their conceptual understanding of physical laws, they use mathematical expressions of these concepts to model problems and solutions for such issues as pollution and energy dependence.
MAJOR **GOAL:** gain essential skills and experience which help create citizens and architects of the future of our planet.
Projects include the Thermodynamics of Clothing and Designing a Passive Solar House.

Keywords: environment, environmental, solar, energy, thermodynamics, online, blended, learning

PS.03.09.W

Strand 7: University Physics

Parallel Session 03.09 Workshop
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D505 (4th Floor)

Cognitive test as a tool for physics learning

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Network instruments of learning physics allow using all Internet information resources accumulated by Humanity and learn physics using PCs, tablets and mobile phones at any place and at any convenient time. Multimedia network instruments are able to create special physics learning space where students:
• get a sufficient amount of information;
• are offered up-to date computer instruments for decision-making;
• get physics competences through the use of new cognitive technologies.

Tests can be represented by various means:
• Hypertext with graphics, charts and tables;
• Video demonstrations of physics processes and phenomena;
• Simulation of physics processes.

Three types of tasks are usually used:
1. Direct choice;
2. Logic choice;
3. Puzzle choice.

The first task is based on the direct recognition of a physics object, for example, the choice of one object of 30 physics formulas located on one Web page. The second one proposes to finish the sentence with the true physics statement. Up to nine sentences adding to each other are given on one page. All sentences gathered together form a final idea of the physics process. In the third type of tasks (puzzle choice), students are proposed to assemble mental construction (maximum - 7 parts) with the given elements.
Strategy and tactics of testing are changing. The semester is divided into five parts with 3-week step. Four types of tests are suggested at each step:
1. Physics pre-test;
2. Physics knowledge check;
3. Physics problems solution;
4. Physics experiments simulation.

The first type introduces students the ideology and structure of the control tests. The most tasks in this test are provided with theoretical explanations appearing in the case of the incorrect answer. The second type of testes is based on the checking of theoretical knowledge (concepts and formulas).The third type offers the solution of the problems of various complexities. To our mind, it is acceptable to take 40 tasks (2 and 3) for 1.5 hours. The fourth one usually consists of 10 tasks with physics applets, seven of which are presented in English and three in the native language.
The control tests are available from Friday evening till Monday morning. One of the most important points is the amount of the attempts given to students for passing the tests. The minimum amount of the unique variants in each test formed from a random choice is not less than ten billion, so students can be offered any reasonable amount of attempts. In our view, it is sufficient to give students 3 attempts.
For students, cognitive tests are intellectual games, and the result is getting competences and real score (in points) that can be improved by the further attempts. Cognitive technology can combine process of getting knowledge, skills and a control procedure. Testing becomes a tool of physics learning with such approach. In our experience, students are ready, able and will working by the proposed algorithm.
It is worth to note that the group of students took active part in the creation of the tests and made essential corrections of their structure and content.

Keywords: Cognitive test, knowledge, direct choice, logic choice, puzzle choice, intellectual games, physics competences

PS.03.10.S

Strand 2: Teaching Physics Concepts

Parallel Session 03.10 Symposium
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D506 (4th Floor)

Teaching and learning the concept of energy from early childhood school through university: PART II

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The learning and teaching of energy has been a rich field for research among students ranging in age from elementary school through university. Many proposals for how to teach the subject have been guided by this research. In a Symposium at GIREP 2008 in Cyprus, several researchers presented findings with implications for teaching energy concepts. One outcome of the Symposium was the conclusion that no clear consensus exists on the structure of a vertically integrated curriculum for teaching energy. A Workshop was held at GIREP 2010 with the goal of making progress toward the challenge outlined above, specifically to make progress toward a unified, research-based view of which energy topics should be taught at which educational level. Since that time a Topical Group on Energy was formed within GIREP. In this set of symposia, researchers from Greece, Italy, Germany, the United States, Israel, Portugal and the Netherlands will report on progress they have been making on the many problems associated with teaching and learning the concept of energy. Symposium speakers will describe their own investigations and place their findings within the context of the goals of the GIREP Working Group. Part I will focus on teaching energy to pupils in preschool and in primary school, as well as strategies for teacher formation. Part II will continue by examining the challenges of teaching the concept of energy to older pupils, in high school and university. Part III will focus on the engaging students in thinking about energy issues in their own lives and the historical development of the concepts.

Participants:
Part I: Teaching the concept of energy to preschool and primary school pupils and teachers
Stamatis Vokos
Department of Physics, Seattle Pacific University, USA
Dimitris Koliopoulos
Department of Educational Sciences and Early Childhood Education, University of Patras
Francesca Leto
University of Perugia, Faculty of Science for Formation, Italy
Marisa Michelini, Lorenzo Santi, and Alberto Stefanel
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Part II: Teaching the concept of energy to high school and university students
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Yaron Lehavi (a), Amnon Hazan (b), Yael Bamberger (b), Ayelet Weizman (b) and Bat-Sheva Eylon (b)
(a) The David Yellin College of Education; (b) Weizmann Institute, Israel
Paula Heron(1), Beth Lindsey(2), Peter Shaffer(1)
(1) Department of Physics, University of Washington
(2) Department of Physics, Pennsylvania State University – Greater Allegheny
Part III: Teaching specific aspects of the concept of energy from social, and historical perspectives
Friedrich Herrmann
Abteilung fur Didaktik der Physik, Universität Karlsruhe, Germany
Ugo Besson, Anna De Ambrosis and Pasquale Onorato
Department of Physics University of Pavia – Italy
Maria José BM de Almeida
CEMDRX, Faculdade de Ciências e Tecnologia, Universidade de Coimbra, Portugal
Matteo Leone (1) and Nadia Robotti (2)
(1) Educational Department, University of Torino, Italy
(2) Physics Department University of Genoa, Italy
Associated POSTERS

Paula R.L. Heron, Marisa Michelini, Bat-Sheva Eylon, Yaron Lehavi and Alberto Stefanel
Report of the Workshop in Girep Conference in France on Teaching about energy. Which concepts should be taught at which educational level?
Bat-Sheva Eylon, Yaron Lehavi, Position paper on energy teaching and learning
Federico Corni, Marisa Michelini, Lorenzo Santi
Report of the Workshop in Girep-Epec Conference in Finland on Teaching and Learning the energy concept and teacher formation in primary school
Yaron Lehavi,
Reproducing Joule's experiment(s)

Keywords: Energy Teaching Learning GIREP TGE

PS.03.11.a

Strand 2: Teaching Physics Concepts

Parallel Session 03.11
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D401 (3rd Floor)

Demonstrations can increase learning…or not

Matthew Bobrowsky
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A large fraction of students view classroom demonstrations as useful aids to their learning (Di Stefano 1996). While demonstrations are widely employed, most instructors are not aware of the research that has been done on how effective they actually are and what can be done to make them more pedagogically useful. Demonstrations can be technically well-prepared, accompanied by a discussion of the major concepts, but with students still learning very little from the demonstrations (Roth et al. 1997).
Traditional forms of instruction are inadequate for helping most students develop a functional understanding of basic topics in science (Kraus 1997). Hearing lectures, reading textbooks, solving quantitative problems, seeing demonstrations, and doing experiments often have surprisingly little effect on student learning. McDermott (2001) found that an effective instructional approach is to challenge students with qualitative questions that cannot be answered through memorization, to help them learn how to respond to such questions, and to insist that they do the necessary reasoning by not supplying them with answers. This can all be applied to how demonstrations are presented.
Demonstrations are used in physics classes for a number of reasons including (1) to illustrate the physics and, hopefully, increase familiarity with the relevant concept, (2) to spark students' interest in the topic at hand, (3) to assess student's understanding of the principle involved, and/or (4) to make the concept more memorable. When presented in a more interactive way, the demonstrations will be much more likely to achieve these goals (Crouch et al. 2004). This provides a tremendous educational opportunity, since demonstrations are so widely used.
This presentation, in conjunction with the presenter's accompanying workshop ("Increase Learning Using Demonstrations") will provide participants with an excellent understanding of how to make demonstrations effective (when they otherwise would not be) by using interactive techniques that engage and challenge the students.

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Keywords: Demonstrations, Pedagogy

PS.03.11.b

Strand 2: Teaching Physics Concepts

Parallel Session 03.11

Date & Time: 02.07.2012 / 14:40 - 16:10

Room: D401 (3rd Floor)

Why are experiments and theory both necessary?

Nada Razpet[1], Tomaz Kranjc[2]

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Experimental work is an essential component in the study and instruction of natural sciences. Instructors demonstrate new concepts through experiments and show causes and consequences when things are happening. They use simplified models in order to observe and explain laws of nature and come up with a mathematical description of relationships between quantities. Or, vice-versa, they illustrate mathematical relationships by experiments. It is through experiments that they try to "convince" students that they have correct relationships. Besides lectures, students in science classes also have labs where they themselves perform experiments under the guidance of lab assistants. This has two purposes, a deepening of the understanding of the content and acquiring of skills necessary for planning and performing of experiments. It turns out, especially during student teaching, that experiments in elementary school classrooms are something that lacks the "convincing power". Students/pupils like them but do not see the essential instructional elements that are the reason for their inclusion. For example, they cannot describe or illustrate a process, write down conclusions and connect them to the content, even though the main characteristics of an experiment are simple and easily seen or even obvious.

Based on the analysis of the results of the exams and difficulties that students encounter in preparing practice in teaching, we chose some typical examples. In the selected experiments (description of a motion, flow of water from different containers, functioning of an electric motor) we tested students to see what is the information and contribution of experiments to the understanding of a certain topic, what connections between "theory" and a given experiment are students capable of establishing, and what ideas they come up with when they perform an experiment and see its outcome. We saw that all phases of an experiment have to be discussed with students in detail and often the experiment has to be repeated. They need to be taught how to illustrate the process, to explain what is happening, emphasize the purpose of the experiment and establish a connection with previous experiments. If this is not done an experiment contributes little to the understanding of a given content and the deepening of understanding. Students perceive experiments and theory as two separate entities and are not able to establish a connection between them, even less to unify them. Also, preparing for exams, students study separately the "theory" (oral part of the exam) and "problem solving" (written test).

Keywords: Primary education, pres-school education, learning/teaching methods, concepts.

PS.03.11.c

Strand 2: Teaching Physics Concepts

Parallel Session 03.11
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D401 (3rd Floor)

How to make content easier for the student

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One of the requirements for Early Childhood and Primary school Education students is a science course that deals with everyday applications of physics.
Students in Preschool Education come from the education high schools which typically have one year of physics while Primary school Education students come from high schools that have the final "matura" examination and two years of physics.
Active student participation is essential for a good understanding and mastering of sciences content. This demands more engagement from students, longer learning, and a training which is no longer a part of the modern instruction. The so called inquires-based ("active") learning and continuous assessment have shown to be an appropriate method. Based on questionnaires in the beginning and the end of lectures, given to a control and experimental group of students, we investigated the success of this active approach in treatment of topics in natural sciences.
In the presentation, we consider some of the problems encountered by these students in studying science courses. The understanding and construction of shadows cast by different objects is one of the topics which is very simple and yet a source of a significant difficulty for students (and thus for future preschool and primary school teachers). Included in the study of this topic are shadows cast by objects illuminated by different light sources (point and extended sources, the Sun), lunar phases, and floating or sinking of differently shaped objects in a variety of liquids. It is important that students obtain a clear and correct understanding of these concepts, since they are fundamental and a part of the required curriculum in pre-school and primary school grades.
We identify difficulties encountered by students in the learning of the above topics and we list common misconceptions. We propose activities to be carried out independently by students so that they can learn how to investigate a given problem on their own and, based on the results, find relationships between appropriate physical quantities. They need to realize that an independent investigation is essential for a good understanding and lasting knowledge. It is only this way that they can be qualified for a critical, logical, and authoritative treatment of this topic. Only if students themselves have experienced it they can see that this kind of approach is also necessary in pre-school and elementary school instruction. Practicing this approach by themselves qualifies them to use it later as teachers and educators. It is also important for them to realize that unsuccessful experiments are not failures but an integral part of learning and therefore a positive experience.
The fact that students have already heard a lot about a given topic and therefore feel that everything is very "simple" and does not need a deeper investigation, poses another difficulty. They follow classroom presentation passively and say that they understand it. However, they have never actively investigated the material and therefore cannot handle it when they are given specific problems. Passive learning instead of an active approach is a part of their study habits.

Keywords: Primary education, pres-school education, learning/teaching methods, concepts.

PS.03.11.d
Strand 3: Learning Physics Concepts
Parallel Session 03.11
Date & Time: 02.07.2012 / 14:40 - 16:10
Room: D401 (3rd Floor)

Teaching and Learning Modern Physics Concepts to Primary Student Teachers

Dimitrios Stavrou
Department of Primary Education, University of Crete, Greece

Relativity and quantum mechanics count undoubtedly as the most significant scientific advances of the twentieth century physics, each fundamentally changing our understanding of the physical world. Although theories of non-linear systems are not as well established as relativity and quantum mechanics, they have contributed considerably to the formation of the contemporary scientific worldview and stimulate multi-dimensional philosophical discussions as well. More recently the emerging fields of nanoscience and nanotechnology promise to have extensive implications for all of society as they apply the unique properties of matter at the nanoscale to create new products and technologies.
The new ideas emerging from the 20th century physics provoke the science educators' interest to introduce basic modern physics concepts in school science curriculum (e.g. Johnston et al 1998; Shabajee & Postlethwaite, 2000; Stavrou et al 2008; Guisasola et al 2009; Hingant & Albe 2010). Nevertheless, modern physics topics often get little attention in physics instruction in schools. School teachers' missing knowledge is often named as a reason. This indicates that the integration of modern physics concepts into teacher training is important both at the university level and in professional development courses for in-service teachers.
The work presented here is an overview of four studies focused on investigating primary student teachers' understanding of basic modern physics concepts. Their capabilities and difficulties in understanding basic concepts from the fields of quantum mechanics, relativity, nonlinear systems and nanoscience were investigated, in a teaching experiment design. Teaching experiment is a kind of interview that is deliberately employed as teaching and learning situation. In a small group setting of 2 students each, twenty student teachers dealt with the particle-wave duality, eighteen with the limited predictability of deterministic chaotic systems, sixteen with the time dilation and twenty six with the size-dependent properties at the nanoscale. The results show that students were capable of sound explanations concerning the topics under inspection. The main difficulties appear to be the result of their pre-/ in-university traditional physics instruction which imposes an "explanatory framework" for the interpretation of physical phenomena stemming from Newtonian physics.

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Keywords: modern physics concepts, deterministic chaos, quantum mechanics, relativity, nanoscience, learning processes, teaching experiment

PS.04.01.S

Strand 9: Teacher Professional Development

Parallel Session 04.01 Symposium
Date & Time: 02.07.2012 / 16:30 - 18:00
Room: D501 (4th Floor)

Understanding teachers' perceptions and pedagogical knowledge for introducing scientific argumentation to science classes: A tentative result from the Korean and Japanese case studies

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Scientific argumentation has been regarded as a core activity in science learning over the world (Jiménez-Aleixandre et al., 2000). Many empirical studies show that the opportunities for students to engage in collaborative discourse and argumentation offer a means of enhancing student conceptual understanding and scientific reasoning skills (de Vries et al., 2002; Driver et al., 2000; Osborne, 2010; Simon et al., 2006; Venville & Dawson, 2010). Nonetheless, it is also pointed out that argument and debate are not the main activity in the ordinary science class, and science teachers' understanding of critical thinking and scientific reasoning still remains low (Forbes, & Davis, 2009; Sanders et al., 1994; Zembaul-Saul, 2009). Hence, it is now realized that the dominant classroom culture that dictates the teacher's and students' roles must be addressed in order to introduce successfully argumentation as the core activity in science learning (Duschl et al., 2007; Sadler, 2004).
In this context, Korea and Japan have many features in common in terms of science learning environments. In spite of the continuous top-rank performance in the international assessment such as PISA and TIMSS, students in both countries are lacking their confidence in learning science (Kim et al., 2008). The parallel situation in two countries provided an apt, comparative research context in terms of the ways in which scientific argumentation can be introduced into science classes.
In this symposium, scholars from Korea and Japan try to open up a cross-cultural dialogue by presenting the case studies focused on science teachers' perceptions as the valuable source for understanding the necessary conditions for introducing scientific argumentation in science classrooms. In each country, more than 12 teachers participated in the semi-structured qualitative surveys. In both countries, teachers considered that argumentation would be important. But the reasons of imporatances were different as well as their perceptions of the proper context of introducing argumentation in classes. Some teachers' responded that the Toulmin's argumentation tool could not be usful to assess their students' argumentation, showing their own images of students' argumentation and social interaction between students. Also, two groups of three Korean teachers participated in one argumentation task, either photosynthesis or mix colors of light. These two cases are the typical experiments of which results are contradictory to the theoretcial expectation because of using cellophane instead of color filters. During the argumentation, the P.O.E (Prediction-Observation-Explanation) strategy had been adopted and teachers were asked to argue after writing down or choosing their own claims and grounds personally. The interviews and argumentation had been recorded by video cameras and voice recorders with field notes. Upon the evidences of teachers' perceptions on teaching argumentation and teachers' argumentation, a tentative model for teacher professional development program will be proposed. The four presentations and discussions in this symposium will be organized in the following order:

1. Japanese teachers' perceptions of argumentation and teaching argumentation in science classes
2. A discussion on the comparative points in teacher perceptions from the Korean and Japanese studies
3. An analysis of teachers' collaborative argumentation: in the case of experiment of photosynthesis efficiency by light wavelengths and mix color of light
4. A tentative model of teacher professional development program for teaching scientific argumentation

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Keywords: science teacher, pedagogical content knowledge, perception, scientific argumentation, photosynthesis efficiency by light wavelengths, mix color of light

PS.04.02.S

Satrand 11: Motivational Strategies and Metacognition

Parallel Session 04.02 Symposium
Date & Time: 02.07.2012 / 16:30 - 18:00
Room: D502 (4th Floor)

A Developed Teaching Model for Metacognitive Thinking: Developed Metacognitive Learning Cycle

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Learning science is sometime difficult for students, particularly when they conduct a specific learning task, such as an experiment or mathematical problem. They often face problems of lacking the plan on which they can rely on and help them connect between the goals of learning tasks and the process to execute these tasks and the outcomes of these tasks. In addition, students are unable to express their scientific thoughts and articulate them in a good scientific manner, let alone their ineffective participation in learning.
Education research have, in recent years, focused on metacognitive thinking strategies to help learners establish attentive control over their thinking and action and help them organize their planning and learning process of the learning tasks.
This study proposed a developed teaching model of the Metacognitive Learning Cycle (MLC), which was developed by Lisa Planck in 2000. It aimed at investigating the effectiveness of the Developed Metacognitive Learning Cycle Model in developing grade 11 Saudi Female students' conceptual understanding of physics and their metacognitive thinking skills. A prior- and post-performance of a research group was measured using three tools: Conceptual Understanding test, Self-assessment scale to measure students' awareness of their ability to use the three metacognitive thinking skills (planning, monitoring and controlling and assessing) and an observation sheet to measure how students practice the three metacognitive thinking skills in the practical activity. The research findings have shown that there is a statistically significant difference (at level <= 0.05) between the post average scores of the experimental group students (taught according to the Developed Metacognitive Learning cycle Model) as well as the control group students (taught in the traditional way) in the total conceptual understanding test. To assess the effectiveness of the Developed Metacognitive Learning Cycle Model in the total conceptual understanding test, the ETA-square ((was calculated; reaching the value of (86%) in the total test. This percentage is of great influence; indicating the effectiveness of the Developed Metacognitive Learning Cycle Model in developing grade 11 female students' conceptual understanding".

Keywords: Metacognitive thinking, Developed metacognitve learning cycle

PS.04.03.S

Strand 14: Socio-cultural Issues

Parallel Session 04.03 Symposium

Date & Time: 02.07.2012 / 16:30 - 18:00

Room: D504 (4th Floor)

The role of physics education for sustainable development in the context of developing countries: challenges and opportunities

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The Centre for Physics Education, Karachi Pakistan and the Engineering and Science Education Research (ESER) group, Melbourne Australia, are proposing a symposium at the World Conference on Physics Education that is being held during 1-6 July, 2012 in Istanbul. The topic of the symposium will engage participants in a focused discussion around two interwoven issues: (a) exploring new ways to strengthen physics at all levels (from primary to university) by promoting quality physics education, and (b) using physics to help solve sustainable development issues.

The aims of the symposium are;

• To review the efficacy of the various activities organized in South Asia to promote physics education, especially the contribution of Asian Physics Education Network (AsPEN) in developing physics education and research during last two decades, and their impact on socioeconomic development.

• To design strategies for the development of physics education so that physics can have a significant role in solving some of the socioeconomic and sustainability problems faced by developing countries.

INTRODUCTION:

The symposium will provide a framework for a discussion around the role of physics education in sustainable development. This framework will include a brief description of the socioeconomic situation in South Asia and the issues that block the promotion of physics and its development. The framework will also include a discussion around the efforts being undertaken to develop physics in a social context and their impact on the teaching and learning environment.

AsPEN and its activities:

For the last two decades, the Asian Physics Education Network (AsPEN) has been striving to set a tradition of quality physics education in the region and it has played a role in introducing a significance change in teaching and learning patterns. In collaboration with international organizations such as UNESCO, AsPEN has launched physics education projects in the region and has influenced many young physicists who are now pioneering physics education reforms (eg; active learning, using computer-based physics labs, developing innovative curricula and initiating research in physics education) in their respective countries. The regional workshops on active learning in physics, which incorporate hands-on, minds-on activity-based learning with low cost experiments have given a new dimension to the teaching and learning patterns in many developing countries. The highly-successful UNESCO Active Learning in Optics and Photonics (ALOP) workshop program has been introduced to the Asian region and teachers have been trained in order to (a) improve their understanding of optics and photonics, (b) develop their ability to actively engage their students, and (c) develop their ability to use local, low-cost resources to complement their classroom teaching. These workshops have changed the perception that teaching a wide range of optics concepts (from ray tracing, to interference to optical communications) requires high cost equipment. In all of its active learning workshops, AsPEN has always adopted simple and low cost methods in its teacher training programs so as to make physics accessible to everyone.

ICPE has also been active in organizing conferences on physics education and motivating young physicists to pay more attention to the issues associated with physics technology, which will play an important role in sustainable development. ICTP has also organized a workshop "PHYSWARE" for teachers from developing countries in 2009.

UNESCO is currently developing an e-learning short course on sustainable development, which can be taken by undergraduate students in the Asian region. Each of the 8 modules was developed by experts from universities in the extended Asian region. This on-line course will give engineering and science students the skills and knowledge they need to understand how their discipline can assist in solving the problems of sustainable development.

Finally, there is the issue of sustaining physics education in developing countries so that it can support the development of physics, which in turn can support sustainable development. It is our belief that sound education research should underpin physics education initiatives. The ESER group in Melbourne has started to collaborate with academics from several developing countries in the Asian region in order to foster physics education research. The eventual hope is that these collaborations will lead to a critical mass of education research expertise in the extended Asian region that will drive informed physics education reform.

There is a message from Mr. Ban ki Moon, the Secretary General, UN and we think it should be the focus of our discussion for future planning.

On January 12, 2012, while launching the International Year of Sustainable Energy for All, the Secretary General of the UN said, "We are here to build a new energy future… a future that harnesses the power of technology and innovation in the service of people and the planet." He further added "It is the golden thread that connects economic growth, increased social equity and preserving the environment."
With this brief introduction to the physics education activities that have taken place (or will take place) in the region and the description of the socioeconomic issues in developing countries, we invite physicists and educators at the symposium to share their thoughts about the activities they have organized in the region and share their experiences with the other participant teachers and students.
Dr. Pratibha Jolly, Principal Miranda College, Delhi University, Delhi India, will be one of the speakers.

Keywords: focusing on development of physics education, developing world, sustainable development, AsPEN activities, accessibility of physics education, strategies to solve the issues

PS.04.04.S

Strand 14: Socio-cultural Issues

Parallel Session 04.04 Symposium
Date & Time: 02.07.2012 / 16:30 - 18:00
Room: D505 (4th Floor)

Changing Perspectives Through Interactions of Diverse Communities

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Collaborative interactions occur at a variety of levels in science education, from students working together on a classroom task, to instructors and administrators negotiating the content or pedagogy of a class, to researchers trying to make sense of what they see in students' behavior. Each of these interactions occur in a multi-level cultural context, and often one that brings together two or more distinct cultural perspectives. In this symposium we present four studies of collaborative interactions conducted by PER groups in two different countries. Members of these groups were responsible for / intensely involved in key curricular reforms: at the University of Maryland (UMD), the physics course for the "National Experiment in Undergraduate Science Education" (NEXUS), and at the Colégio Técnico, Universidade Federal de Minas Gerais (UFMG), the high-school level "Currículo de Física em Espiral" (CFE). Such involvement had some bearings on the investigations each group has conducted lately. Here are brief summaries of the studies we chose as examples of four levels of collaborative interaction in physics education:
Study A: Faculty collaboration – Designing an interdisciplinary physics course
The goal of the NEXUS course reform is to recreate the introductory physics course for life science majors in a way that better fits the needs of biology majors and pre-health care professionals. Specifically the project is attempting to create a course that builds general scientific competencies and is perceived as of authentic value in understanding biology by both biology students and faculty. A large team of physicists, biologists, and chemists have gotten together for extensive discussions of this course, both on general content and to discuss specific issues. Although all of the participants are scientists, each brings elements, orientations, and expectations from their particular scientific discipline. These scientific sub-cultures often conflict in the language they use and the assumptions they (perhaps tacitly) make, even for the "same" topic. One example is the way the different disciplines talk about molecular binding and energy. In this part of the symposium we will present an example of distinct disciplinary perspectives and how they were resolved in our course design.
Study B: Research collaboration – Crossing the levels of action
A significant component in the NEXUS physics class are group physics problem-solving activities that have authentic biological value. These are worked on by students in groups of 3-5 in small-class environments, facilitated by teaching assistants. The development of the course materials are based on a research/design model in which student behavior is videotaped and then analyzed by the research team. These observations weave together three distinct levels of group interaction and practice:
(1) Student learning – In this course, students are asked to learn to "think like physicists" and to seek consistency across their disciplinary science knowledge. This often challenges students' cultural assumptions about learning and the scientific disciplines. In our focal episode, we see some students readily taking up tools from physics while others are actively striving to draw on knowledge from chemistry and biology courses.
(2) Education research – The research team analyzes videotapes of the student discussions on the task and it takes a group activity to extract meaning from student dialogue.
(3) Curriculum reform – What the research group learns from their analysis has implications for teaching practice that need to be renegotiated with the instructional level members of the team.
We will analyze the implications of the group interactions using videoclips of student behavior and field notes of the research group discussion.
Study C: Theoretical Collaboration – Resorting to scholarly fields of knowledge
When PER investigators study new classes there is a risk of only seeing what they expect. The risk might be even higher if previous research results were used in the design of the curriculum, its materials and pedagogy. The study we present here resulted from an attempt to improve classroom observation of high school students in the new CFE physics class. We wanted to detect barriers to students' development during enquiry, collaboration, and dialogical argumentation. We saw that some groups created effective learning opportunities occasionally, but no groups did it with consistency. Since we inferred that gender issues were involved, we analyzed our observations using Connell's Social Theory of Masculinity. We will illustrate this process presenting data about groups where the boys' patterns of behavior inhibited collaboration among students. These patterns became particularly clear when we analyzed the role some girls played in mixed gender groups.
Study D: Student-Researcher Collaboration – Group interview about classroom instances
The CFE reform relied on students' discovering learning opportunities in physics classes for themselves. To

evaluate the extent to which this occurred in the curriculum, we devised a research methodology inspired by Paulo Freire's pedagogy and stimulated recall technique. We interviewed groups of eleventh-grade students who had participated in the curriculum themselves. They were prompted to recall their own experiences by watching video recordings of tenth-grade students engaged in similar activities. This helped the researchers understand actions and cognitive processes in the collaborative classroom activities of the tenth-grade students in the video. In addition, the collaboration with the eleventh-grade student observers helped researchers understand those students' own experiences and development in CFE activities. For example, the eleventh-graders reported that after they experienced the activity, they no longer expected teachers to be the only source for knowledge. They made explicit how they re-elaborated the solution of many problems and cognitive challenges they faced in physics classes. They made statements about immediate effects that some class activities had. They also talked about long-term effects, for instance, learning to make sense of lab and class activities. The interview structure encouraged them to talk about problematic situations previously encountered and to analyze the difficulty initially experienced with some of the concepts and practical problems they were presented with.

Keywords: Collaborative Action; Scientific Authenticity; Learning Opportunities; Investigative Process;

PS.04.05.S

Strand 2: Teaching Physics Concepts

Parallel Session 04.05 Symposium
Date & Time: 02.07.2012 / 16:30 - 18:00
Room: D506 (4th Floor)

Teaching and learning the concept of energy from early childhood school through university: PART III

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The learning and teaching of energy has been a rich field for research among students ranging in age from elementary school through university. Many proposals for how to teach the subject have been guided by this research. In a Symposium at GIREP 2008 in Cyprus, several researchers presented findings with implications for teaching energy concepts. One outcome of the Symposium was the conclusion that no clear consensus exists on the structure of a vertically integrated curriculum for teaching energy. A Workshop was held at GIREP 2010 with the goal of making progress toward the challenge outlined above, specifically to make progress toward a unified, research-based view of which energy topics should be taught at which educational level. Since that time a Topical Group on Energy was formed within GIREP. In this set of symposia, researchers from Greece, Italy, Germany, the United States, Israel, Portugal and the Netherlands will report on progress they have been making on the many problems associated with teaching and learning the concept of energy. Symposium speakers will describe their own investigations and place their findings within the context of the goals of the GIREP Working Group. Part I will focus on teaching energy to pupils in preschool and in primary school, as well as strategies for teacher formation. Part II will continue by examining the challenges of teaching the concept of energy to older pupils, in high school and university. Part III will focus on the engaging students in thinking about energy issues in their own lives and the historical development of the concepts.

Participants:

Part I: Teaching the concept of energy to preschool and primary school pupils and teachers
Stamatis Vokos
Department of Physics, Seattle Pacific University, USA
Dimitris Koliopoulos
Department of Educational Sciences and Early Childhood Education, University of Patras
Francesca Leto
University of Perugia, Faculty of Science for Formation, Italy
Marisa Michelini, Lorenzo Santi, and Alberto Stefanel
Research Unit in Physics Education, Department DCFA, University of Udine, Italy

Part II: Teaching the concept of energy to high school and university students
Michael Pohlig
Wilhelm-Hausenstein-Gymnasium, Durmersheim, Germany
P.S.W.M. Logman (1), W.H. Kaper (1) and A.L. Ellermeijer (2) logman@uva.nl
(1) Faculty of Science, University of Amsterdam, The Netherlands and
(2) Centre for Microcomputer Applications, Amsterdam, The Netherlands
Yaron Lehavi (a), Amnon Hazan (b), Yael Bamberger (b), Ayelet Weizman (b) and Bat-Sheva Eylon (b)
(a) The David Yellin College of Education; (b) Weizmann Institute, Israel
Paula Heron(1), Beth Lindsey(2), Peter Shaffer(1)
(1) Department of Physics, University of Washington
(2) Department of Physics, Pennsylvania State University – Greater Allegheny

Part III: Teaching specific aspects of the concept of energy from social, and historical perspectives
Friedrich Herrmann
Abteilung fur Didaktik der Physik, Universität Karlsruhe, Germany

Ugo Besson, Anna De Ambrosis and Pasquale Onorato
Department of Physics University of Pavia – Italy
Maria José BM de Almeida
CEMDRX, Faculdade de Ciências e Tecnologia, Universidade de Coimbra, Portugal
Matteo Leone (1) and Nadia Robotti (2)
(1) Educational Department, University of Torino, Italy
(2) Physics Department University of Genoa, Italy

Associated POSTERS
Paula R.L. Heron, Marisa Michelini, Bat-Sheva Eylon, Yaron Lehavi and Alberto Stefanel
Report of the Workshop in Girep Conference in France on Teaching about energy. Which concepts should be taught at which educational level?
Bat-Sheva Eylon, Yaron Lehavi, Position paper on energy teaching and learning
Federico Corni, Marisa Michelini, Lorenzo Santi
Report of the Workshop in Girep-Epec Conference in Finland on Teaching and Learning the energy concept and teacher formation in primary school
Yaron Lehavi,
Reproducing Joule's experiment(s)

Keywords: Energy Teaching Learning GIREP TGE

JULY 3, 2012
TUESDAY

P1.G01.01

Strand 1: ICT and Multi-Media in Physics Education

Poster Session - 1.01

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Science with sensors in primary schools

Ewa Kedzierska, Ton Ellermeijer
Foundation CMA, Amsterdam, The Netherlands

The use of ICT in Physics Education is well-known for many years, and has proven to stimulate f.i. more authentic and inquiry-based education. Already for 25 years CMA has developed the learning environment Coach for science education. Coach includes a.o. tools for measurement with sensors, measurement from videos, powerful analyzing tools including Modeling and authoring facilities to create activities adapted for age 10 – 20.

In more recent years a special interface has been developed having Primary schools (and their teachers!) in mind. This interface, a little pink box called €Sense, has built-in sensors for light, temperature and sound. Also an external temperature sensor is provided. The interface takes it power from the USB-connector, to avoid batteries and power supplies. The design looks friendly and not too technical.

During the last decade we experienced with the use of Coach in Primary schools, as well in The Netherlands as well in international contexts (f.i. Pollen Project). First with a more complex interface. Later on with the €Sense.

Based on these experiences activity books with Coach activities have been developed with many examples for the different sensors of €Sense. The interactive poster presentation aims participants will become familiar with the interface and the teaching materials including Coach activities.

P1.G01.02
Strand 1: ICT and Multi-Media in Physics Education
Poster Session - 1.01
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Problems associated with the use of multiple representations in a high school physics course, within the traditional context

Guillermo Neumann[1], Pilar Segarra[2]
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One problem that persists in Mexico is the gap between educational research and classroom work. Ideally it would be expected the immediately implementation of the results of educational research included in the study programs, however, the change in teaching practice have shown to be very slow.
The use of new technologies in the classroom is one of the proposed changes set within the curriculum of Mexican high school education. The laboratories are being reformed to consider multiple representations as the principal line of work (simulations, graphs, algebraic representations, reading and writing texts).
Among the identified skills of scientists are those related to the use of multiple representations under different circumstances, these are the reasons for the importance of including activities with MR in physics courses.
This change implies a transition period in which students and teachers involved in traditional settings should establish a relationship with new tools and methods. It implies a change in the activities carried out and the time devoted to them, involves raising new goals, develop new skills and ways of evaluating and changing the values in both learners and teachers.
Traditional context is defined as that where the teacher is the main protagonist and learning is measured by solving numerical exercises and writing reports on demonstration activities. The research question is what difficulties arise with the systematic use of still and moving images within a context of traditional education?
The exploratory and qualitative study was conducted over two semesters in a public high school at Mexico City, with a group of 28 students from high school introductory physics. The researcher was associated with the teacher. Various activities were created in which two-dimensional images, still and moving, were the center of attention. The activities with images were intercalated to the traditional class and in some cases were left as homework. The activities required that the students familiarize themselves autonomously with the simulator of physical phenomena (PhET), after which they faced situations of read-write still images, related to the models used in the theoretical or experimental traditional classes.
The study shows difficulties for both the student and the teacher. In the case of students, the use of simulators and still images showed the following problems: data extraction, interpretation, relationship between different representations, etc. Teachers were faced to the problem of the creation of activities that simultaneously fulfill the objectives of learning and research tools; we have also difficulties integrating within a quantitative scoring system the answers given by students to the new type of activities.
A qualitative assessment was made from a survey on the opinion that the students have in the use of simulators in the classroom. We found that although students recognize the importance of the simulations for learning, they consider them more difficult and less valuable than traditional forms of teaching that are closely related to their score.

Keywords: multiple representations, image, high school physics, simulators

P1.G01.03
Strand 1: ICT and Multi-Media in Physics Education
Poster Session - 1.01
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

POOLkits: Applying Object Oriented Principles from Software Engineering to Physics Object Oriented Learning – Preliminary Concepts

Thomas J. Kassebaum[1], Gordon J. Aubrecht, II[2]
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Since the development of object-oriented programming techniques in the 1980s, software development has become more modular with more manageable code. These same practices have been applied to the development of Learning Modules utilizing object-oriented learning as the basis of the modules. The benefits of teaching learning objects lie in the transference of the object-oriented model directly to identical techniques in object-oriented programming since both learning objects and software objects are constructed using the same underlying principles. The obvious gains in applying object-oriented learning are most easily seen in object-oriented programming classes where the teaching of the learning object flows directly into the practice of programming the software object. However, physics provides a rich object-oriented basis for the development of learning objects and has a rich software development history, as well.
Object-oriented development depends upon the creation of generic pieces that can be built into more complex parts. In physics, we begin teaching basic principles and then move into more complex systems, a perfect environment to develop learning objects. Each learning object consists of observable quantities, such as the physical properties of a block of wood, and operators that act on the object, such as force. Additionally, each object can also include an assessment operator that evaluates the impact of the learning object on student comprehension.
The physics object-oriented learning kits (POOLkits) will be developed to enhance student understanding of physics concepts, as well as, build a framework for developing a software object based on the physics concept. A POOLkit can be extended, similar to the concept of extending classes in object-oriented programming, as physics knowledge expands. The expectation for these POOLkits would be to provide physics students with a solid foundation in the first principles to be able to derive more complex formulae and have the understanding of the process with a secondary benefit of enhancing the object-oriented programming capabilities of physics students.

Keywords: software, object-oriented programming

Wolfram Mathematica in Theoretical Physics

Radim Kusak
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Computer Algebra Systems (CAS) like Wolfram Mathematica or Maple are very powerful tools for science and education. CAS has wide range of applications in many fields of science and economy because of powerful symbolic manipulation tool, visualization and also numerical methods. Also derived products like Wolfram|Alpha, Wolfram demonstration project, MapleSim and Maple T.A. can be very useful in education. CAS can be integrated into physics curriculum at universities in many ways. Basic integration can start from general purpose lecture focused essentially on CAS with some examples from many different areas of interests, across seminars focused on general topic like physics or selected physics lecture to the usage of small parts of CAS like visualization or data analysis. One of the last of its usage is very useful because it offer improvement of current subjects without change of the Curriculum. In our case for usage of CAS was chosen seminar of Theoretical Physics in Faculty of Mathematics and Physics at Charles University of Prague.
In this paper first steps of integration of Computer Algebra Systems into the seminars of Theoretical physics with some examples are presented. Theoretical Mechanics is ideal course for CAS's involvement. Even difficult tasks like Euler–Lagrange equation or Hamilton's equations can be easily solved by Mathematica with very few commands. If solution of task cannot be obtain analytically, is possible to use approximations like Taylor series or use numerical methods integrated in CAS to solve it. No matter if tasks is solved by numerical or symbolical methods all steps and results of the tasks are done within one program.
In first part of this paper are shown some tasks solved by Mathematica and general ideas of its structure and purpose. Each of solution of the tasks take great amount of time, because before releasing the solution certain conditions must be met. First is solution itself. Obtaining solution in physics is very important, but usually only author of such solution understand all steps to obtain it. That why the second part is to make understandable steps to get the solution. Third part is Physics correctness. If some part of solution lose its physics meaning it suppose to be commented. Last part is visualization of task.
In second part of this paper are suggested methods of CAS's usage in seminars and lectures similar to Theoretical Mechanics. Methods of using Computer Algebra Systems are divided into two parts – time scale methods and degree of CAS's involvement. These methods will play key role in future of this project, because solved tasks will be map to those methods.
In third part of this paper are presented results of the brief survey on Theoretical Mechanics and CAS. Survey took time in the last seminar's lesson of Theoretical Mechanics and give brief information about difficult parts of Theoretical Mechanics and usage of CAS by students.
Materials and methods presented in this paper are part of larger research project about Computer Algebra System and its impact on student's understanding of physics concept and problem solving in physics.

Keywords: Computer Algebra Systems, CAS, Physics, Physics education, Theoretical Mechanics, CAS in Theoretical Mechanics, CAS's Methods

P1.G01.05

Strand 1: ICT and Multi-Media in Physics Education

Poster Session - 1.01

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

The key competences and teaching physics with the ICT for IST Pack

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[2]C.M.A.
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The key competences recommended by the European Commission oblige teachers to use the new technologies and issue new challenges to education; the roles of both teacher and student also change (European Parliament, 2006). On the other hand, new curricula limit severely the number of hours devoted to teaching of physics and other science subjects. One observes the growing number of educational institutions engaged in international and national projects that are supported by EU funds. Care should be taken that teaching and learning of science subjects, supported by new technologies, develop students' creativity and stimulate their creative thinking, giving notable educational benefits. The teacher needs good teaching materials that will facilitate this kind of teaching.

The ICT for IST Pack - the final result of the ICT for Innovative Science Teachers project (2009-1-PL1-LEO05-0546), which involved a partnership of six educational institutions: Computer Assisted Education and Information Technology Centre (PL) – project coordinator, Loughborough University (UK), Foundation CMA (NL), University College of Teacher Education (AT), University of Cyprus (CY) and Charles University in Prague (CZ), contains exemplary educational materials for teaching science with ICT at secondary schools. The pack includes twelve modules with different student activities and software resources, ten instructional videos and a Resource Guide for teacher trainers and science teachers. The materials focus on the use of both Coach 6 and Insight software packages, and additional ideas for software solutions, interactive investigations and a range of free software. The videos demonstrate some of the practical activities from the modules. These can be useful for tutorial discussion or as the basis of follow-up activity after the course, either for reinforcement or for self-study.

A few sample activities from chosen ICT for IST modules will be presented on poster to illustrate how the software tools are employed in complementary ways to promote understanding of the concepts involved.

Keywords: key competences, ICT for IST project, ICT, data-logging, modelling, data video

P1.G01.06

Strand 1: ICT and Multi-Media in Physics Education

Poster Session - 1.01

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Demonstration of the heat with the ICT based real-time thermo viewer camera for elementary school

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We have demonstrated a visible heat and thermodynamics by using a conventional thermo viewer camera based on ICT for elementary school science.
Teachers of the elementary schools always face difficulty to teach heat. In the elementary school of Japan, the primary schoolchildren learn the heat and the temperature in fourth graders scientifically. We know that they have the naive concept that a daily life experience causes till then, and contact with scientific heat and temperature for the first time. It is not easy to understand to children about the heat and the temperature, because it is not easy to show them to teachers themselves. The invisible change of so called heat and conduction of the heat cannot appear directly in nature. So children in the classroom only get some evidences to suggest such the phenomena have happened by teacher's demonstration in most cases. For example, a metal board which sewed wax is observed to be able to dissolve, or as for the sticking thermo tape, it is observed the change being changed at temperature a colour. Even though some example of the thermography can be seen in the textbook, they can only have such the indirect experiences in deed. One of the reason why to teach the heat and temperature is quite difficult is due to such the poor situation and high price of these devices.
Recent innovation may solve the problem. We came to be able to purchase in Japan typical thermo viewer approximately 200,000 yen (about 2,500 USD), which has not only thermo viewing mode, but also standard digital camera mode simultaneously. Using this camera, we devised a demonstration that we were connected to the PC. In other words, it is the thermodynamic demonstration of the ICT base which is available in an elementary school. By the presentation, we are going to introduce the details and the practice example of this demonstration in the elementary school.

Keywords: thermo viewer camera elementary school

Multimedia enhanced physics lecture experiments (ePhEx)

Guillaume Schiltz
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Classroom demonstrations are a substantial element of introductory physics lectures. The learning effect of these experiments, however, is discussed controversially [1][2]. While pure observation has almost no positive effect on conceptual learning, interaction or at least engagement with the given experiments shows clear benefits [3].

ETH Zurich holds a collection of more than 700 lecture experiments covering all major topics of experimental physics. These experiments are exhaustively used in all introductory lectures and address about 3’000 students per year. The project ePhEx aims at raising student’s engagement with those experiments. It allows students to review the experiments beyond the lecture hall and to work more extensively with them. During the lectures we still present experiments in the traditional way. Students, however, additionally get internet links to the corresponding enhanced experiments and can review them in detail while revising the lecture.
The project ePhEx offers the following features through a public web site (http://ephex.phys.ethz.ch):
- Video recording (with audio explanations) of the experiment.
- Text description (with graphics/pictures) of the physics behind the experiment.
- Interactive simulation (Java applet) allowing students to run the experiment with individual settings.
- Application exercise (with optional solution) based on the experiment.

Up to now we have a stock of 106 videotaped experiments, most of them augmented by a detailed description. 35 simulation applets and 20 exercises have been included so far. We plan to continually increase the collection in the next two years and to end up with the 200 most prominent experiments. In 2011 we started to supplement selected lectures with additional enhanced experiments and the feedback has been encouraging. Further systematic evaluations including usage and preferences will be carried out in 2012.

In our presentation we want to discuss the multimedia approach that we are pursuing and more generally to question the status of traditional lecture experiments.

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Keywords: video, applets, web, OER

P1.G02.01

Strand 2: Teaching Physics Concepts

Poster Session - 1.02

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Discursive Interactions between Teacher and Students in Physics Classes and Construction of Arguments

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Actions, attitudes and activities performed by teachers in classroom practice differ according to their needs and goals. All these variables for teacher behavior are aimed to the construction of knowledge by their students. Therefore, it is essential do conduct a study focused on teachers' actions that makes it possible to identify the transformation and evolution of the knowledge acquired by students.

We decided to investigate the role of a teacher in the construction of arguments performed by his/her students by means of a qualitative study. We analyzed two classes in video format that were previously investigated for a different research purpose. The classes are part of a teaching sequence of the 3rd year at secondary level in a public school. The classes were held on the same day, one after another, and addressed the topic of duality of light, which is part of a broader context that is Modern Physics. The inquiry-based teaching prioritized the development of students' reasoning. We spent a great deal of time analyzing the discursive interactions, using different theoretical references based on authors such as Vigotski, for whom knowledge is constructed during the interactions between the subject and the objects of learning, and Toulmin, who characterizes the argument as a logical structure that organizes data and claim with the warrants that support them. This enabled us to classify and categorize the arguments used during the class. It became clear to us that the claim of the teacher throughout the analyzed classes was that students constructed arguments about the content of the discipline. Thus, he/she provided the elements that allowed students to solidify their previously studied conceptual bases in order to sustain the new issues.

Subsequently, we developed three guiding elements that are closely when the development of knowledge and reasoning of students in the classroom is considered: Subject – it is the students; Instrument – tools used during the class to assist the students in the development of reasoning; and Object – content of the discipline. The students are supposed to construct their knowledge based on this content. These elements are interconnected through the actions of the teacher and can be expressed in a spiral diagram, that is, after the student internalizes the desired object with the instrument provided by the different actions of the teacher, this object becomes an instrument. Then, a new object is elaborated and developed.

The transformation of the object into instrument was observed in the speeches of students at various moments of the analyzed classes. Classroom analysis showed that the teacher's role is the role of a mentor. The teacher's questioning during the classes allowed the students to participate in the investigation and assisted the collective construction of the arguments. Therefore, we can affirm that, by performing different actions in his/her classroom practice, the teacher provides the tools with which the students will construct their learning of the discipline studied.

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TOULMIN, S.E. Os Usos do Argumento. São Paulo: Martins Fontes, 2° Ed, 2006.
VIGOTSKI, L.S. Pensamento e Linguagem. 2ª Ed. São Paulo: Martins Fontes, 2000.

Keywords: Arguments; Discursive interactions; Modern Physics

P1.G02.02

Strand 2: Teaching Physics Concepts

Poster Session - 1.02

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Misconceptions of Scientifically-gifted in physics

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We compared the physics comprehension of science high school students with this of general school students by analyzing results obtained in the research for designing physics teaching methods and developing physics instructions. For comparison by subjects in physics, we applied the concentration analysis method introduced by Bao et al.(2000). We applied the method to results taken with 102 questions in "The database of student's physics misconceptions"[Song et al, 2004]. The data are taken from the total number of 4452 students in 11th grade of general high schools and 3381 science-gifted students in 10th and 11th grades of science high schools in Korea. As for the conceptual understanding of physics, the ratio of correct answer of gifted students was higher than general students in all domains, significantly, "Force and motion", however, in the "wave and light" field, both groups had the similar ratio. And our result that the ratio of correct answer of gifted students was lower in the "the questions about magnetic properties of matter by electromagnet and image by the lens" is very impressive. We also obtained the "Concentration factor" C and "Concentration of the incorrect responses" in order to compare the consistency of comprehension. We have found that the C value was high when the correct-answer rate of the corresponding questions was high, and there was not any correlation between C and. The value were distributed broad from 0 to 1 according to question. This result shows that gifted students also have strong misconceptions of physics, or they do not apply physics conceptions consistently to questions in various contexture.

Keywords: Scientifically-gifted, Misconceptions, Concentration factor, Concentration of the incorrect responses

P1.G02.03

Strand 2: Teaching Physics Concepts

Poster Session - 1.02

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Teaching about energy. Which concepts should be taught at which educational level?

Marisa Michelini[1], Paula Heron[2], Bat Sheva Eylon[3], Yaron Lehavi[4], Alberto Stefanel[1]
[1]University of Udine
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WORKSHOP organized by Paula R.L. Heron and Marisa Michelini,
with the cooperation of Bat-Sheva Eylon, Yaron Lehavi and Alberto Stefanel

Participants
More than 30 colleagues participate to the Workshop offering an important contribution to the wide discussion. Here we report the names and the e-mail addesses, thanking the Girep Committee for the decision to recognize a GIREP Thematic Group on Energy Teaching and Learning.
Pavlo Antonov, Esther Bagno, Ugo Besson, B. Blondin, Marina Castells Michele D'Anna, Maria José de Almeida, Bat Sheva Eylon, Igal Galili, Zofia Golab-Meyer, Paula Heron, Pedro Jorge, Dimitrios Koliopoulos, Yaron Lehavi, Olga Lendaltseva, Paul Logman, Mariani Cristina, Michelini Marisa, Ana Rita Mota, Valerie Munier, Nikos Papadouris, Gesche Pospiech, Joel Rosenberg, Lorenzo Santi, sassi elena, Alberto Stefanel, Laurence Viennot.

The learning and teaching of energy has been a rich field for research among students ranging in age from primary school through university. Many proposals for how to teach the subject have been guided by this research. In a Symposium at GIREP 2008 in Cyprus, several researchers presented findings with implications for teaching energy concepts. One outcome of the Symposium was the conclusion that no clear consensus exists on the structure of a vertically integrated curriculum for teaching energy. Such a curriculum would allow the coherent introduction of aspects of energy at appropriate ages and ensure continuity from year to year as children progress through the educational system. Some countries have devised national standards or guidelines that include recommendations for different aspects of energy at different grade levels. However in many cases these have not been guided by research. GIREP members are in a unique position to be able to make recommendations that are consistent with our knowledge of how students learn and the special conceptual challenges posed by the topic of energy.
The goal of the Workshop was to make progress toward the challenge outlined above, specifically to make progress toward a unified, research-based view of which energy topics should be taught at which educational level.
Before the workshop two contributions were sent by Dimitris Koliopoulos of University of Patras, Greece and Joel Rosenberg of U.C. Berkeley, California, USA, respectively on teaching energy in preschool and primary education and on Energy for Everyone. This contributions become part of the work group activities: the relative abstracts are reported at the end of this report.
Another contribution for the Workshop discussion was offered by Bat-Sheva Eylon and Yaron Lehavi from Israel by means of an artifact for the DISCUSSION: What has changed? - Energy as the language of changes. The text of this contribution is reported after the abstract mentioned.
The Workshop activity was introduced by Marisa Michelini with an overview of the approaches to energy in research literature, a brief report on 2008 Energy Workshop held in Girep Conference in Cyprus and a suggestion of problems to be considered for the WS discussion. Alberto Stefanel presented a research literature overview of the learning problems on energy concept. At the end of this report a single paper offers a critical analysis of the approaches and the learning problems in energy teaching/learning and a bibliographic contribution for an overview of research contributions.
Paula Heron discussed the main results of the Workshop emerging from the discussion organized in three big groups, working for about 90 minutes on teaching/learning energy in primary, low secondary and upper secondary school. In the following the report of Group responsible are reported. The position paper produced by the workshop activity is reported as last part of this report.

Keywords: Girep GTE Workshop Energy Teaching Reims

P1.G02.04
Strand 2: Teaching Physics Concepts
Poster Session - 1.02
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Dismantling rainbow

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The observation of natural phenomena is the most obvious starting point of the scientific approach to knowledge. In spite of this trivial remark, we observe that, at least in Italy, the large part of school lessons is held in the form of frontal lectures, in which teachers propose a defined set of information following a standard lesson plan. In this framework, the direct observation of phenomena is inserted as examples to confirm theory.

We present a didactic route to the learning of elementary optics starting from the rainbow. The basic idea is to start from the bare observation of the natural phenomenon and to guide students to the discovery of every single optical process governing it.

The idea to focus on rainbow as a useful example for teaching optics is not new [1-4]. In most of the proposed paths, the discussion of the rainbow is used to summarize the concepts of standard geometrical optics courses (reflection, refraction, dispersion, vision…). At variance with them, we want to reverse the learning process so that the explanation of each single optical process included in a standard optics curriculum for High Schools will emerge naturally as a demand for understanding the main phenomenon, the rainbow. At the end of the course the students should at least reach the same content knowledge level achieved by traditional teaching, but with greater satisfaction.
The "dismantling" of the rainbow takes advantage of the indoor reproduction of the rainbow by using a glass sphere (raindrop) and a white-light projector (sun) or cylinders of transparent materials (glass, plexiglas, glycerol) and a collimated white light beam or laser beams at different wavelengths. The quantitative analysis of the experiments is carried on by taking pictures/movies of the setup and analyzing them with analysis software like Tracker Video.

We have tested the didactic path with university sophomore students (physics laboratory) to calibrate each step, then we proposed it to a number of High School classes: we will present the results of comparative tests between parallel classes some of which have followed the course and some other have followed a more traditional didactics.

[1] Y. Sakurada and T. Nakamura, Demonstration of the light scattering phenomenon in the atmosphere, "Seventh International Conference on Education and Training in Optics and Photonics," Proceedings of SPIE 4588 (2002).

[2] H. Isik and K. Yurumezoglu, Two Simple Activities to Bring Rainbows into the Classroom, The Physics Teacher 50 (2012) 38

[3] A. W. Hendry, A Triple Rainbow?, The Physics Teacher 41 (2003) 460.

[4] R. D. Russell, A rainbow for the classroom, The Physics Teacher 27, (1989) 262.

Keywords: Rainbow, fundamental optics, atmospheric optics, secondary education

P1.G02.05

Strand 2: Teaching Physics Concepts

Poster Session - 1.02

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Teaching concepts of electromagnetism, optics and modern physics through situations in medicine

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This research aims, mainly from the use of many teaching resources, at promoting students' meaningful learning. With this in mind, we used several tools, such as a supporting text, experimental activities, new technologies, concept maps, and problem-situations. Such tools were applied along four implementations of a course for teachers and future teachers of physics using concepts of physics applied to medicine. Through qualitative and quantitative analysis, we investigated whether these tools had favored the students' meaningful learning. To achieve the objectives proposed in our research methodology, we proceeded through the following steps: 1) a review of the literature in the journals classified by CAPES (a Brazilian agency for graduate courses) as A1, A2 and B1, from 2000 to 2009; 2) a study of alternative materials for the development of instructional resources to be used in the course; 3) development of suggestions for educational activities; 4) organization of semi-structured interviews, pre-tests and post-tests; 5) application of the designed course; 6) application of the interviews, pre-tests and post-tests; 7) data analysis; 8) course improvement; 9) re-application of the course; 10) re-application of the interviews, pre-tests and post-tests; 11) data analysis to look for the presence of meaningful learning instances; 12) comparison between the studied groups to seek for any evidence for what could be the best way to teach such a content. At all stages of the experiment, we used Ausubel's theory of Meaningful Learning (2002), Moreira's theory of Critical Meaningful Learning (2005), Vergnaud's theory of Conceptual Fields (1999, apud Moreira 2004a, p. 13), and Toulmin's epistemology (1977). Research findings suggested, among other things, that the teaching of physics applied to medicine seemed to be a scarcely researched area; differentiated methodologies apparently facilitated the emergence of meaningful learning evidences; the use of computer simulations, together with experimental activities, seemed to facilitate meaningful learning; guiding questions could be rather relevant to the development of computer simulations.

Keywords: physics teaching, physics applied to medicine, meaningful learning.

P1.G02.06
Strand 2: Teaching Physics Concepts
Poster Session - 1.02
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

The Coherent Structure of Classroom Discourse in Teaching Physics Concepts

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There are several analytic frameworks (e.g. conversation analysis and discourse analysis) for interpreting classroom discourse. In this presentation, the analytic framework with using dynamic semantics (Ohno, 2011) is applied to interpret the records of science classroom discourse in teaching physics concepts. The reliance on linguistic information, compositional and lexical semantics, is maximized and the non-linguistic information such as beliefs, intuitions, world knowledge, is treated as occasion requires through the interpretation process. The rhetorical relations of SDRT (Asher and Lascarides, 2003) are used to connect each utterance to the other parts of discourse in the interpretation. A discourse is coherent when all utterances in the discourse are connected to others and all anaphoric expressions have been solved. For example,
s1: This cable is hot.
s2: An electric current is running.
If you can connect the utterances s1 and s2 with the rhetorical relation of Explanation, the phrase "an electric current" in s2 will be considered to mean that an electric current is running through the cable mentioned in s1. This short discourse becomes coherent.
The result of the interpretation is represented as a diagram. The diagram of classroom discourse branches off and grows vertically and horizontally. The structures of coherent discourse in class can be identified easily by using the diagrams. Various types of science classroom discourse are investigated and represented by the diagrams in this presentation. Those structures are compared. The dependence on educational content and teaching strategies like setting some choices beforehand for students are considered. We will also study the situation which promotes students' argumentation in teaching physics concepts.

Ohno, E. (2011). Analytic frameworks for studying science classroom discourse with dynamic semantic approach. In the poster presentation of GIREP-EPEC 2011, Finland.
Asher, N. and Lascarides, A. (2003). Logics of Conversation. Cambridge, UK: Cambridge University Press.

Keywords: discourse, analysis, rhetorical relation, coherent, interpretation

P1.G03.01
Strand 4: Laboratory Activities in Physics Education
Poster Session - 1.03
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Modeling Activities with Prospective Physics Teachers

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Current secondary school (grades 9-12) physics curriculum [1] stresses the use and importance of new instructional methodologies to make students physically and mentally active. For this reason, it is important for (prospective) physics teachers to develop–preferably by engaging in learning activities employed in such instructional methods–knowledge and skills in using these methods. One of the methods that would help students become actively involved in their own learning is "modeling". Modeling is an instructional method that organizes the course around models [2, 3]. Halloun and Hestenes [4] used the modeling theory in physics instructions by refining Kaplus' learning cycle [2, 5]. Wells, Hestenes and Swackhamer believed that every physics problem can be solved by modeling [2]. Modeling helps students understand scientists and scientific processes by considering and controlling variables of physical events. During the modeling process, students try to solve problem phases by identifying researchable questions given in problem situations and explore their own conceptions of the subject matter related to the problem situation. In this study, we describe two modeling activities: One is an activity on modeling "belt friction", developed by us; and the other is a well-known activity–modeling simple harmonic motion in "simple pendulum". Based on the ideas of pioneers of modeling in physics education [2, 3, 6], we have employed modeling activities in a laboratory course for prospective physics teachers. We used these activities in two laboratory sessions, each lasting four hours. During the activities, we observed prospective teachers' positive attitudes toward and high motivations in "modeling". In addition, we observed that prospective physics teachers were successful in the model development phases such as description, formulation, ramification, and validation of the model. With this research, we discuss both theoretical and experiential process of modeling by means of two modeling activities. In this regard, this study might be helpful for (prospective) physics teachers in two ways: (1) Prospective physics teachers' positive approach towards modeling and success in modeling while learning physics might motivate physics teachers to use this methodology in their physics classes while teaching physics, then physics teachers may use these modeling activities in their physics classes, and (2) they may develop new modeling activities by using our approach to enrich their physics classes.

References:
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Keywords: Modeling; physics laboratory; teacher education.

P1.G03.02

Strand 4: Laboratory Activities in Physics Education

Poster Session - 1.03

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Reproducing joule's experiment(s) in teaching the concept of energy

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In his famous series of experiments, Joule claimed to find relations between heat and other phenomena e.g. chemical affinity, electromotive and electro-magnetic forces and even the passage of water through narrow tubes. Joule's experiments, and especially the mechanical equivalent of heat (MEH) experiment, provided a standard measure of processes belonging to domains in nature considered to be disconnected. They laid the basis for our understanding of the concept of energy change as a measure of such processes. Moreover, the fact that there is no dynamical relation for the Joule MEH experiment renders its importance for justifying the use of the energy language. (Arons, 1999)

Surprisingly, however, Joule's MEH experiment was excluded from the curricula, symbolizing degradation in the status of energy conservation in physics education. (Robinault, 1998) That, in spite of Joule's experiments importance for teaching the subject of thermodynamics.(Sichau, 2000)

Therefore, due to the great importance of joule's conclusion with regard to the generality of his standard measure of different phenomena, it is highly desired to reproduce his main experimental results. In this paper we introduce a very simple device by which one can relate a change in height, speed and spring's length to the process of heating a "standard" body. The temperature rise of this body might be agreed to be the measure of the change in the quantity of energy in the process causing it. The device enabled us to arrive experimentally at the known relations between the change in the amount of energy related to the different mechanical processes and the variables that characterize them.

The experimental setup

The heart of our system, the standard body, is a small copper tube (~1 cm in length, 3 mm in diameter), placed within a wooden block. In this tube, we embedded the sensor of a regular lab thermometer. Around the tube we warped a string, which its upper end could be connected to the axis of a bicycle wheel (with added weights), while its lower end could be connected to a weight or to a spring (the pictures bellow show the apparatus with a falling weight).

Experiments and results

Experiment 1: heating by the process of falling

We arranged the setup as described in the above picture. We first dropped the same weight from different heights until it reached its final height and then let different weights fall from the same height. In each time we measured the temperature rise in the copper tube from the beginning of the process to its ending. The wheel was used to monitor the process and to ensure that the change from the initial state of the weight to its final state will involve only the change in height and not in speed. The results of this experiment are illustrated in the following graphs:

Experiment 2: heating by the process of spring contraction

In this experiment, we employed the same setup as before but instead of a falling weight we connected to the lower end of the string a spring which was held down to the floor. We then stretched the spring to several lengths and let it contract. In each time we measured the temperature rise in the copper tube from the beginning of the process to its ending. The wheel, as before, was used to monitor the process and to ensure that the change from the initial state of the string to its final state will involve only the change in its length. The results of this experiment are illustrated in the following graph:

Graph 2: Measurement of energy change (by temperature change) in the process of elastic contraction. x denotes the extension of the spring over its loose state

Experiment 3: heating by the process of speed change

In this experiment, we connected the string's lower end to a weight (to keep it tense) and the upper end was held free. We began the experiment by spinning the wheel and measuring its speed (by a regular bicycle speedometer). We then attached the string's upper end to a hook connected to the wheel's axis and waited until the motion of the wheel was stopped. We repeated the process for several initial speeds and in each time measured the temperature rise in the copper tube from the beginning of the process to its ending. The results of this experiment are illustrated in the following graph:

Conclusions and dicussion

The first experiment verifies rather well Joule's results with respect to a falling body, according to which the change in temperature is linearly proportional to both the change in height and to the mass of the falling body:

1) ΔT α m·Δh

The last two experiments extend Joule's results to two more processes: an elastic contraction and a change in speed of a body:

2) ΔT α Δ(x2)

3) ΔT α Δ(v2)

respectively.
If one accepts the idea that temperature change of a standard body can define (operationally) the change in the quantity of energy in the above processes, one can attribute the above relations to such changes. In other words, one may claim that relations 1 to 3 describe the change in the quantity of energy in the processes of falling, elastic deformation and speed change respectively.
We therefore highly recommend the integration of the above described experiments into any curricula addressing the subject of energy.

Keywords: Laboratory Activities in Physics Education, Teaching Physics Concepts; Learning Physics Concepts; Secondary School Physics

P1.G03.03
Strand 4: Laboratory Activities in Physics Education
Poster Session - 1.03
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Anisotropy is everywhere

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Anisotropic materials are nowadays more and more significant in science and technology (for example liquid crystals in LCDs). Even though the students are often in touch with such materials as they are so common in our everyday life, they are not aware of the anisotropy as one of the key properties that enable the hi-tech products they use so eagerly. This is partly because the concept of anisotropy and in particular the consequences of the anisotropy, such as birefringence, are rather difficult to comprehend. Therefore it is important to introduce the concept of anisotropy to students with as illustrative examples as possible, according to their current knowledge of physics and mathematics.

Anisotropy is a general term describing that a particular property depends on direction, i.e., the material does not have the same properties in all possible directions. Anisotropic properties are caused by the anisotropic structure of the material. The main idea of this contribution is to present three different experiments that help students develop conceptual understanding of the anisotropy. The experiments are performed sequentially, starting with the most simple and intuitive one and finishing with the most complex one.

In the first experiment a knitted pullover can be used as an anisotropic material. It is known that a knitted cloth extends in one direction differently than in the other. Samples with different knitted patterns help us to demonstrate the concept of anisotropy - the directionally dependent elastic constant. The knitted cloth is acting as a spring, which can be stretched in any chosen direction. The dependence of the extension due to the applied force of constant magnitude on the direction with respect to the knitting pattern is easily observed and measured.

The second experiment is based on the anisotropy of wood. No particular effort is needed to persuade students about wood being an anisotropic material, because fibre-like structure is observable with a naked eye and anisotropy is quite obvious. As wood is easy to cut in a desired direction, a few centimetres thick wooden plates with different fibre orientation are easily prepared in order to show birefringence and to measure anisotropic refractive index of wood in the microwave region. By measuring the amplitudes of polarised microwaves after propagating through different wooden plates the dependence of the extraordinary refractive index on the angle between the incident beam and the fibres can be demonstrated qualitatively. Fitting the observed values with the theoretical predictions enables quantitative results, but this can only be done at the university level because it requires higher mathematical skills.

The last and the most complex experiment that illustrates anisotropy in the refractive index is based on liquid crystals. A laser pointer and three wedge cells with different molecular orientations of nematic liquid crystal are used. Due to the birefringence of the liquid crystal, two bright dots are observed, when a beam of non-polarised laser light is passing through the wedge cell. Each dot corresponds to one of the two eigenvalues of the refraction index of the liquid crystal in the wedge. The ordinary and the extraordinary refraction index are determined from the measurements of the geometry of the setup, i.e, from the position of the dots relative to the wedge and the angle between the incident beam and the wedge.

All three experiments aim at improving the conceptual understanding of the anisotropy as a general structure dependent property of materials. Going from simple mechanical (knitted cloth as an anisotropic spring) to complex dielectric (wedge nematic cells as optical elements) examples enable students to get an insight into modern technological products they come across in their everyday life, such as liquid crystal displays. This is one particular aim of the proposed experiments. Performing the experiments students develop step by step the understanding of the anisotropy. At each stage they use the knowledge and understanding obtained at the previous stage which finally leads to the generalization of the concept of the anisotropy. The impact of the experiments on the conceptual understanding of the anisotropy was tested with the second year in-service physics teachers. Results of the testing will be reported.

Keywords: anisotropy, knitting, liquid crystals, wood, conceptual understanding

P1.G03.04
Strand 4: Laboratory Activities in Physics Education
Poster Session - 1.03
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

A comprehensive assessment strategy for physics laboratory courses

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It is now well established that the physics laboratory training is supposed to develop in students, a variety of important cognitive and psycho-motor abilities related to experimental physics, which include, conceptual understanding, procedural understanding, experimental skills, experimental problem solving ability, etc. But it has been noted that that strategies adopted for the assessment of what students learnt through a laboratory course, are often inconsistent with the above mentioned objectives of the laboratory courses. The results / grades are often too subjective and poorly discriminate among the students. It is felt that these strategies are often non-discriminatory, inadequate from the point of reliability and validity and unsatisfactory as an achievement test. In this paper, an assessment strategy, developed by the author is presented, which can be used at the college and university level.

The strategy presented in this paper is based on four tools or components of assessment, namely, test on conceptual understanding, test on procedural understanding, an experimental test and the continuous assessment, with an appropriate emphasis on each. The first two are paper and pencil type tests, which correspond to a single variable each, namely, the level of a student's conceptual understanding and the procedural understanding respectively. The third is centered around the variable 'experimental skill', but is not a single variable measure; rather it is a composite measure of the experimental skills, problem solving ability, conceptual understanding and procedural understanding. It is difficult to isolate the contributions of each of the four variables to this composite measure. The fourth is based on students' regular laboratory work throughout the semester / year.

The paper will give details of all the four tools of assessment, with respect to type of questions, design, grading schemes, administration of each tool etc. This paper will also give a set of sample questions/tests for each tool of assessment.

To conclude, one must realize and appreciate that fact that the assessment strategy, based on which, each student is assessed and given grades that appear in the final score, is a factor, which directly or indirectly affects the seriousness and the effectiveness of the laboratory course. Therefore it is essential to have focused and collaborative efforts by the PER community for the development of strategies for the laboratory courses.

Keywords: Physics laboratory course, assessment strategy, tools of assessment, conceptual understanding, procedural understanding, experimental skills, continuous assessment

P1.G03.05
Strand 4: Laboratory Activities in Physics Education
Poster Session - 1.03
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

An Inquiry Based Approach to the study of concept of distribution in statistical mechanics

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Many research results have highlighted how much the understanding of the concepts of physics can be influenced by the conceptual difficulties connected with their mathematical representation. In fact, mathematical representations are the basis for scientific descriptions and very often students have difficulty in understanding the uses and limits of these representations.
Possible difficulties may include understanding a graph, which is generally defined as "interpretation" or identifying the "meaning of a graph", and its construction starting from data provided in the form of a table. Research has also shown that students are helped to understand by learning to use scientific and mathematical representations, like graphs and equations, and investigating the content in a specific and concrete context.
With regard to the concept of distribution, the difficulties in understanding mentioned above have been highlighted in several studies.
The distribution concept is a fundamental component of statistical thinking. It can be seen as a lens through which the variability that exists in various phenomena in the real world can be looked at with greater clarity. Examples of this include the distribution of values in the analysis of experimental data and the related uncertainties, and the dynamics of the systems formed by many particles. In this last case, the distribution is concerned with the variation of a physical variable (energy, velocity) between the individual particles that make up a molecule sample (statistical mechanics).
The contexts mentioned above are clearly very different. However, it is not difficult to find analogies between the two sample procedures, and it is not uncommon to find students who see the distributions of molecular velocity as a consequence of the uncertainties involved in the evaluation of the velocity itself.
The proposed teaching method described in this work is intended as a study of the concept of distribution in its characteristic aspects, like average value, more frequent value, variance, variability etc., and seeks to overcome the difficulties previously mentioned. For this purpose a very specific activity for Engineer students, related to the field of statistical mechanics, is proposed, in which the concept of the distribution of velocity or the energy of a gas is dealt with using an Inquiry Based experimental examination of Maxwell's Law. In particular, the experiment and the subsequent processing of the data allows the distribution of the velocity of the gas of electrons emitted by a metal as a result of a thermionic effect to be determined.
The examination of Maxwell's law, using thermionic valves, was carried out by H. Germer in 1925 during his time at the laboratories of "Bell Telephone". This work is of particular importance because of the accuracy of the results obtained.
It is on this experiment that the experimental activity proposed to the students is based. To sum up, the procedure used allows the particles to be selected by grouping them together on the basis of their speed, and determining their frequency. The methodology mentioned before is clearly the basis of the construction of any statistical distribution. The same procedure can also be repeated at a varying temperature, therefore allowing more distributions to be compared in relation to the sizes that characterise them.
By using this procedure we aim at allowing the students to understand the fundamental aspects of the distributions in the field of statistical mechanics. Although it is applied to a specific field, this methodology can also be effective in different fields such as the social and economic phenomenons.

Keywords: Teaching methods and strategies, Laboratory experiments and apparatus.

P1.G04.02

Strand 3: Learning Physics Concepts

Poster Session - 1.04

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Prospective Science Teachers' Misconceptions about Energy

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Science and technology literacy is emphasized in the science curricula of many countries. One of the important dimensions of science and technology literacy is attaining improved understandings of the key scientific concepts. Many studies about science and technology literacy emphasize 'knowing science concepts and understanding the meaning of them'. It is a fact that science and technology teachers and teacher candidates have to understand the scientific concepts in order to raise students who are comprehend scientific concepts. 'Energy' is one of the most important key scientific concepts. It is visible not only in physics, chemistry, biology, and their relations to the environment, but also in science-technology-society-environment contexts. In addition, an inspection of Turkish science curriculum reveals that energy concept occupies a wide place from 4th to 8th grades in many teaching units.

The purpose of this study is to find out the knowledge of science and technology teacher candidates about energy and reveal the misconceptions if any existed. The participants were 131 teacher candidates of Mehmet Akif University Science Teacher Program. Teacher candidates were addressed three questions. These questions inquire the concepts of mechanical energy, kinetic energy, potential energy, and the relations among above three. The questions which are prepared by the researchers include examples from daily life. Each of the questions has three stages. In the first phase, teacher candidates marked the choice which they believed to be true. In the second phase, they explained their justification. Finally they defined their level of certainty (strongly sure, sure, not sure, I do not know). Three physics education experts were consulted to find out the levels of questions' ability to reveal the misconceptions, understandability and accuracy. Questions were rearranged according to the experts' advices before application.

Analysis of data is performed in three phases. In the first phase, answers to the questions were grouped according to the choices. In the second phase, justifications to the choices were examined. Using content analysis, similar justifications were grouped producing common statements. These statements were inspected by two field experts. It was found out that, experts were in total (100%) agreement with the researchers. In the final phase, level of certainty was inspected.

68% of the teacher candidates successfully related the concept of kinetic energy to the mass, speed and altitude of an object. Almost 30% of the teacher candidates possessed the misconceptions "kinetic energy of an object is inversely proportional to the distance", "kinetic energy of an object is proportional to the distance", and "Kinetic energy of an object depends on the way of distance". A great majority of the students who have the misconceptions stated that they were sure about their answers.

71% of the teacher candidates successfully related the concept of potential energy to the mass and altitude of an object. Nearly 28% of them possessed the misconceptions "potential energy of an object is related to distance" and "potential energy of an object is related to the velocity".

Almost half of the teacher candidates successfully related mechanical energy to kinetic and potential energy. Other half had one of the misconceptions "mechanical energy is related to the velocity", "mechanical energy is related to the distance", and "mechanical energy is the sum of change in the energy".

The students which successfully answered the questions about concepts of kinetic and potential energy stated that they were 'strongly sure' or 'sure' about their answers. When the certainty levels of the question about mechanical energy concept are examined, it was found out that half of the students were not sure of their explanations where the other half was 'sure' or 'strongly sure' of their explanations. The justifications and explanations of the majority of successful candidates were true but there were also numerous missing and false explanations.

Teacher candidates, who have some misconceptions about science concepts, may sustain their misconceptions as future teachers. This possibility raise the idea of their future students share their recent misconceptions. The researchers think that awareness and correction of teacher candidates' misconceptions about key science concepts would contribute to training of future generations as science literate individuals.

Keywords: Energy, misconceptions, teacher candidates.

P1.G04.03
Strand 3: Learning Physics Concepts
Poster Session - 1.04
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Learning physics and astronomy in a middle school class: a design experiment

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We present a design experiment (Cobb, Confrey, diSessa, Lehrer and Schauble, Design Experiments in Educational Research, 2003) conducted in an Italian middle school class. We carried out a three years experience about physics and astronomy teaching. The class was composed by 20 students of 11-14 years old, with gender and nationality differences. The learning environment was designed to be rich and interactive and with multiple instruments and models to collect, represent and interpret the data.
Our starting point was a learning progression (NRC, Taking science to school K-8, Washington D.C. National Academies Press, 2007) about basic concepts in astronomy K-8 based on our previous experiences in learning and teaching astronomy and physics. Focusing on big ideas of motion and light properties, this progression suggests a three-phases educational pathway:
- the topocentric phase: from the observation of the daily and nightly sky above the local horizon to the interpretation of the Sun and Moon phenomena both in terms of frames of reference and galileian relativity and light propagation from sources with different dimension and increasing distance
- the geocentric phase: from the daily and yearly observation of the Earth illumination to the interpretation of the seasons phenomenon in terms of variation in illumination hours and inclination of sun rays in respect with different positions of the Earth
- the heliocentric phase: from the observer and the Earth perspective to the interpretation in the heliocentric frame of reference.
We planned a teaching proposal based on this progression and we implemented it in the class collecting qualitative data (photos, audiotapes of discussions and written reports). The testing and revising process was informed by ongoing analysis of students responses and potentialities of the learning environment.
We present the results of the retrospective analysis of the entire experience.

Keywords: astronomy, physics, design experiment

P1.G04.04x
Strand 3: Learning Physics Concepts
Poster Session - 1.04
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Mass from classical physics to special relativity: learning results

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Mass is a fundamental physical quantity, present in almost all school curricula, from primary to high school level. It shows a manifold character: Newtonian physics established inertial and gravitational facets together with the metaphysical "quantity of matter". In Special Relativity (SR), we must add the relation with internal energy (rest energy). In some formulations of SR the quantity "relativistic mass" is used as a proper physical quantity, even if nowadays most of the scientific community considers it useless and misleading in terms of teaching [Okun, 2001].
This multifaceted character of mass as well as the persistence of the ontological vision as quantitas materiae makes the concept very difficult to understand soundly. By the way, we recall that in General Relativity mass-energy modifies the geometry of space-time.
The following learning difficulties were found in high-school textbooks: identification of weight with gravitational mass; belief that a beam balance measures weight; inertial mass defined operationally through F/a, where, as a literature example, F is the measurable force impressed by a compressed spring. On the subject matter ground, quantitas materiae vision has also generated misconceptions concerning the mass-energy relation: mass is converted into energy, in a generic sense (6 high-school textbooks); E=mc^2 represents conversion of mass into energy (1 high-school textbook); confusion/mistakes between energy conservation law and mass conservation law (3 textbooks) [Lehrman, 1982].
In addition, it came out a teleological-qualitative view of mass preferred to operative-quantitative-formal (scientific) vision [Doménech, 1993].
For these reasons, we sustain the importance of building an unitary framework, which can give significance to the fragmentary conception present in the different theories involving mass. We therefore carried out an exploration of the ways used to learn the concepts above by strongly motivated students; we also inquired how they have put these ideas in relation. Our aim was to find what students' lines of reasoning are, in absence of any other learning difficulty. In particular,
1) How and in which contexts students related themselves to the term "mass" and make use of it?
2) How do students interpret the extension of the concept "mass" to "mass as rest energy" in the relativistic context (under the influence of our path)?
We took a sample of 42 talented students, selected for attending a modern physics summer school. Our activity consisted in an interactive tutorial, on historical basis, with proposals for individual reflections and group discussions. We gave each student some working sheets outlining the whole path, with a number of open and closed questions inside. In the written post-test we asked the role of mass in everyday life of students, also in term of phenomena; what theories of physics study these phenomena; their ideas of quantity of matter; the connotations they gave to "mass" and if the inertial mass of a body depends on its energy (apart from the kinetic energy). For our investigation on their relativistic mass conceptions, we simply asked to define it explicitly.
As preliminary results, some interesting elements turned out. For instance, the phenomena evoked in semantic areas familiar for the students are in large part mechanical ones; the pre-theoretical conception of quantitas materiae is rooted in most of their minds; there is awareness of the importance of mass in electromagnetism in a few students. Mental representation of mass seems related to the learning environment: we noted a local view of the mass in SR in a context defined by speed and a grasping of the concept of mass in SR as limited to a "chapter" of physics. Eventually, the young talents show very good ability to formalize, the relationship mass-rest energy being an exception in this regard: the "relational" level of representation [Doménech, 1993] is prominent.

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Keywords: mass, mass-energy, rest energy, quantitas materiae, inertial and gravitational mass, relativistic mass, talented students, interactive tutorial

P1.G04.05

Strand 3: Learning Physics Concepts

Poster Session - 1.04

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Investigating thermoimaging in augmented multisensory learning about heat transfer

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Infrared (IR) thermal imaging is a powerful technology which holds the pedagogical potential of 'making the invisible visible', and is becoming increasingly affordable for use in educational contexts. Science education research has identified many challenges and misconceptions related to students' learning of thermodynamics, including disambiguation of temperature and heat, and a common belief that our sense of touch is an infallible thermometer. The purpose of the present study was to explore how thermal imaging technology might influence students' conceptual understanding of heat and temperature. This was carried out by investigating three different conditions with respect to students exploration of the thermal phenomena of different objects (e.g. wood, metal and wool), namely the effect of students' use of real-time imaging generated from a FLIR i3 IR camera, students' interpretation of static IR images, and students' deployment of traditional thermometer apparatus. Eight 7th-grade students (12-13 years old) worked in pairs across the three experimental conditions, and were asked to predict, observe and explain (POE) the temperature of a sheet-metal knife and a piece of wood before, during and after placing them in contact with their thumbs. The participants had not been exposed to any formal teaching of thermodynamics and the ambition was to establish if they could discover and conceptualise the thermal interaction between their thumbs and the objects in terms of heat flow with minimal guidance from the researchers. The main finding was that a cognitive conflict was induced in all three conditions, as to the anomaly between perceived 'hotness' and measured temperature, with a particular emotional undertone in the real-time IR condition. However, none of the participants conceptualised the situation in terms of a heat flow. From the perspective of establishing a baseline of the understanding of thermal phenomena prior to teaching, extensive quantities, e.g. 'heat' or 'energy', were largely missing in the participants' communication. In conclusion, although an unguided discovery or inquiry-based approach induced a cognitive conflict, it was not sufficient for adjusting the students' conceptual ecologies with respect to the age group studied here. Future research will exploit the promise of the cognitive conflict observed in this study by developing a more guided approach to teaching thermal phenomena that also takes full advantage of the enhanced vision offered by the thermal camera technology.

Keywords: Thermoimaging, augmented multisensory learning, discovery learning, heat, conceptual change, cognitive conflict

Reasoning and models of talented students on electrical transport in solids

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Electrical phenomena and relative transport properties are the basis of broad spectrum of applications and are included in curriculum at all ages for learning important concepts involved in their description (current, field, potential,.). The approaches are mostly of experimental explorations, but is missing an organic and coherent integration with electrostatic and electromagnetic phenomena both on macroscopic as microscopic level. The treatment of circuits may be included, where it is necessary linking the conceptual meaning of physical quantities (potential, current) with the systemic vision, overcoming local reasoning (Psillos, 1997). Building the link between the macro/micro levels of description of processes is a relevant aspects for learning (Ganiel & Eylon, 1990; De Posada, 1997; Wittmann & et al., 2002). Then, the goals of this study are to determine: 1) what are the critical aspects of students' reasoning about microscopic processes that play a role in the interpretation of phenomena? 2) how do different activities (simulations, experiments, analogies) favorite the integrate interpretation on macro/micro levels and how they could be used in different contexts? 3) how it's possible to overcome the dilemma of displaying microscopic world? (Mashhadi & Woolnough, 1999; Seifert & Fischler, 2003) 4) how could be approached the actual quantum mechanics description in continuity with classical model? (Lomax, 1992) 5) how do the students report on quantum model when it is presented to them?
To collect best students' reasoning and models we did a tutorial with a sample (N=40) of talented students selected from the whole Italian secondary schools to take part in a school of excellence in modern physics. They were engaged in concrete and abstract contextual situations. The data were collected during a brief tutorial that explores the following aspects: nature of the electrical charge, potential, current and resistance, processes of electric conduction in solids, dependence of metals and semiconductors resistance on temperature. The personal involvement of subjects in phenomenology actives the interpretative processes, therefore the tutorial use the conceptual interpretative tools of IBL methodology (Abd-El-Khalick & et al., 2003)
Data analysis was performed in a qualitative way, organizing in conceptual classes the interpretations, the reasoning profiles and the different uses of concepts.
Preliminary results show that: 1) the conceptual interpretative tools of IBL methodology promote the evolution of student' ideas from the common sense to the scientific view; 2) connecting the electrical phenomena to structure of matter not only was a major success of physics, but it is also a possible way to address the widespread and persistent difficulties that students encounter in understanding interpretative microscopic models.

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Keywords: teaching/learning electrical transport properties

P1.G05.02
Strand 7: University Physics
Poster Session - 1.05
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

The evaluation of a basic training text-book on physics with method of entry and drill for university students majoring in liberal arts

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We aim at making university students majoring in liberal art who want to become an elementary school teacher get to understand and like physics with the aid of a basic training text-book which we produced in 2010. In Japan, it was pointed out that a lot of students dislike science as well as mathematics recently on the White paper about science and technology published by Ministry of education, culture, sports, science, and technology Japan in 2006. This problem is regarded as one of the most important ones in social science, and many researches have been carried out.
The establishment of elementary school teacher training course has been increasing rapidly at women's university with a faculty of liberal arts and so on. It has been started in 2009 as well at Kobe Kaisei college. In previous study, for 87 freshmen in 2009 at our college, it became clear that the amount of 51% students hated science, the 70% hated physics though only 34% hated biology. There was the same tendency for 6 students who wanted to become an elementary school teacher as for the 87. Then it is considered that there are a lot of students who dislike science because they dislike physics.
Therefore, in order to reduce the physical hate we created 'Basic physics training text-book using the method of entry and drill'. We created two of types texts. One is for students and the other is for teachers. Much space is provided to transcribe the points on Power Point slides shown by a lecturer for student's. Furthermore, there are examples and exercises in the text-book. Students listen to explanation of the points and examples from the lecturer, then they can solve its exercises in it.
After the students attended a class using this text-book, all of them got to be able to solve the exercises and to like physics. All strongly supported the method of entry and of drill. However all couldn't solve the exercises including two step processes. It can be considered that if one more step should be added to this text-book, they get to like physics more and more. Here it is confirmed that because one of six students chose a science class in high school, the text-book is easy for her and an applied exercises are needed for her.
In this instructional design idea, the students majoring in liberal arts who dislike physics got to be able to solve the easy exercises through writing work by the aid of our original drill text-book, so that they get to like physics. It is hoped that they get to like physics more and more by solving more high level exercises.

Keywords: drill, entry, elementary school teacher, liberal arts

P1.G05.03
Strand 7: University Physics
Poster Session - 1.05
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Using the Force Concept Inventory and the Force and Motion Conceptual Evaluation to assess the effectiveness of the interactive engagement approach in introductory physics instruction at a Japanese university

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Pedagogical studies conducted over the past two decades in the United States have demonstrated that many recently developed active learning or interactive engagement (IE) strategies are intrinsically more effective than traditional approaches. The normalized gain on a multiple choice test used as a measure of student understanding of Newtonian concepts is about 0.2 for students taught with the traditional approach and in the range of 0.3 to 0.6 for students taught with the IE approach. Most faculty members of Japanese universities adopt traditional approaches in teaching introductory physics. Their prevailing belief is that student learning largely depends on students' preexisting knowledge—not on teaching strategies. University students' preexisting knowledge can be characterized by the type of university entrance examination written, the type of high school physics curriculum taught, and the scores achieved on a mathematics aptitude test. This study uses the pretest and posttest of the Force Concept Inventory (FCI) and the Force and Motion Conceptual Evaluation (FMCE) to examine the effectiveness of students' conceptual learning in terms of teaching strategies and students' preexisting knowledge. We assessed the test results of 450 first-year university students attending an engineering school at Kochi University of Technology who had taken an introductory mechanics course. We divided them based on teaching approaches: Two groups were taught with a traditional approach, and one group was taught with IE strategies. Peer instruction and tutorial recitation teaching methods were used with the group taught with IE strategies. The FCI was administered to half of the students in each group before the first class and before the final examination for an introductory mechanics course, and the FMCE was administered to the other half of the students in each group at the same time. The normalized gains of the two groups that had been taught with a traditional approach for both the FCI and the FMCE were about 0.2, whereas the normalized gains of the group that had been taught with the IE approach were about 0.4; the results were consistent with those previously found in the United States. We analyzed the pretest and the posttest scores based on the following information about students: (1) the university mathematics placement test score, (2) the type of high school physics curriculum taught, (3) the type of university entrance examination written (some students are admitted to university based on the recommendation of their high school without having to write an academic aptitude test), (4) gender, (5) the national aptitude examination score, and (5) the type of instruction strategies employed in an introductory mechanics class. We found the instruction strategy to be, by far, the most effective contributor to students' understanding of Newtonian concepts. The IE instruction resulted in large learning gains, regardless of the students' preexisting knowledge, whereas the traditional instruction resulted in small learning gains, which means that the posttest score reflects their preexisting knowledge.

Keywords: Force Concept Inventory, Force and Motion Conceptual Evaluation, interactive engagement approach, Japanese university

P1.G05.05

Strand 7: University Physics

Poster Session - 1.05

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

A proposal of learning based on projects and problem solving on musical acoustics

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Musical acoustics deals with the physical and psychoacoustical principles underlying the production and perception of musical sounds. This old experimental science provides an excellent introduction to the Physics of acoustical systems, and it shows a great potential for students' original projects at all educational levels.

In this work, we present a proposal of project based learning, dealing with the generic properties of the vibrations and sounds of musical instruments. The project is related to some Acoustic concepts, such as resonant systems, frequency spectrum, sound pressure levels, transients, psychoacoustic parameters, acoustic impedance, etc that are important in some branches of Physics and Engineering. It has been designed and intended for students of undergraduate programs of the Faculty of Engineering of Bilbao.

One of the problems of the Musical acoustics that has attracted attention and interest, is to find the reason of the apparent superiority of old Stradivarius and Guarnerius violins, over their newer counterparts that are often near exact copies of the older. Many explanations have been proposed: a magic recipe for the varnish, the special quality of wood resulting from microclimate changes, etc. However, as the recent research shows, the differences in taste among individual violinists, along with differences in playing qualities among individual instruments, appear more important than any general differences between new and old violins.

This project-based-learning approach proposes to the students the study of the acoustical attributes of a cheap violin and the comparison of the obtained results with those summarized in literature for old Italian instruments. During the development of the project, the students have to work with:

- the vibrational modes of stringed instruments
- the radiation of sound by such structures
- the characteristics of the sounds of individual instruments
- the subjective assessment of the quality of musical instruments
- the relation of the playing qualities to the measurable attributes of the instruments

This type of learning methodology can be easily extended to the study of wind and percussion instruments.

Keywords: PBL, Acoustics

P1.G05.06

Strand 7: University Physics

Poster Session - 1.05

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Project based learning in Architectural Acoustics

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In the last decades a growing interest towards the acoustical quality in buildings has been detected, and we can cite the birth of new acoustical regulations in various European countries. When designing or restoring a room for speech and music, the focus will be on cultivating the useful components of the sound in the room, and on avoiding noise from outside and from installations.

The Physics of sound and vibrations has always played a main role in the basic formation in Engineering. However, many engineering students find that this basic training is insufficient for the work to be engaged in some companies. As a result, they demand to the University the opportunity to enhance their knowledge with complementary elective courses or developing some projects.

This work gives an overview of some of the students' projects that are related to acoustic design, acoustic restoration, and loudspeaker installations in classrooms and halls. The projects were developed by undergraduate students of the Faculty of Engineering of Bilbao. Teachers, students or industry proposed the problem that became the basis for the project work. Under teachers' supervision, the students analyzed the problem and, after working on possible solutions, they had to implement one of the options.

Keywords: PBL, Acoustics

P1.G05.07
Strand 7: University Physics
Poster Session - 1.05
Date & Time: 03.07.2012 / 13:00 - 14:00
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Solid state physics - new approach in the Electromobility programme

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In recent years, a new bachelor study programme called Electromobility was established at the Czech Technical University (CTU) in Prague. Considering the aims of CTU in Prague - to educate students for their future technical practice - the main goal of this subject is to extend the theoretical background of leading technologies in the industrial applications. We established new subject called Solid State Physics and Tribology in order to introduce the problems of materials, surface engineering and friction, namely the structure of the solid body, the basics of crystals formation, their defects and disordering and, mainly the outgoing physical and chemical properties of the solid materials and surfaces. We used the modelling software Crystal Impact Diamond for demonstration of the crystals formation, defects generation and effects of macro-, micro- and nanoscale loading. This education approach helps better understanding of the 3D structure formation and the macroscopic properties of crystalline materials as the consequences of microstructure. The second part of the subject is aimed to the problems of surface engineering. The theoretical background given by solid state physics is extended to the industrial materials properties. The surface geometry is defined and, based on this premises, the basic contact behaviour of two real surfaces is introduced. Students meet the problems of solid-body friction and the effects of these phenomena on the industrial materials performance and lifetime are defined. Consequently, the modern techniques of surface treatment are introduced. This course is aimed to the thin coatings deposition. The practical part of the subject is focused on the modelling of crystalline structure, defects and properties calculations, and, second, on the thin film deposition (physical and chemical vapour deposition) and consequent characterization of the mechanical, chemical and tribological properties, such as thickness, adhesion, hardness, chemical composition, structure, friction coefficient, wear rate and wear debris characterization. The main goal of the subject Solid State Physics and Tribology is to introduce the modern techniques of surface treatment that could lead to the energy savings due-to-friction. Unfortunately, the global political position counts with wide expansion of green technology regardless on all financial and resources incidents. However, many of these “green” approaches, such as efficiency and energy savings, could be fully solved by improvements based on the friction problems. It is well known that the mechanical systems lose their efficiency mainly due to friction. These dissipations could reach even about 30 %. The best green technology could save about 5 % of total energy demands, if ever. Students being prepared for the technical practice should be able to think about the advisability of the state-of-the-art technological solutions. Besides the theory of solid state and surface engineering, this subject should spark off a debate about the sense of "green fever" with regard to the technological demands and the total energy input.

Keywords: Solid state physics, tribology, wear, green technology, energy savings

P1.G05.08

Strand 7: University Physics

Poster Session - 1.05

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Room: D406 (3rd Floor)

Undergraduate Students' Perceptions of the Introductory Physics Laboratories

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Physics is considered to be a tough and abstract discipline, and introductory physics courses do little to change this negative attitude towards physics (Blickenstaff, 2010). Yet, research studies have shown that students usually enjoy working in the laboratory (Deacon & Hajek, 2011; Hanif, Sneddon, Al-Ahmadi, & Reid, 2009; Sneddon, Slaughter, & Reid, 2009). This could mean that laboratory sessions may be a chance to dispel the bad reputation of physics. However, the other line of research reported that even though laboratories are expensive with regards to resources and the time spent by students and staff, laboratory sessions generally are not considered to be a valuable learning experience (Kirshner & Meester, 1988). In this respect, it is important to make sure that the students enjoy the laboratory sessions and ascertain whether they are able to develop conceptual understandings about difficult topics in physics. Previous studies reported different kinds of issues that need improvement in laboratory instructional designs, despite the fact that students have positive attitudes towards physics laboratories. Although laboratory experience is considered to be important in student learning, there is little research in Turkey which investigates undergraduate students' perceptions of the laboratories where the cookbook implementation is predominant. The purpose of this study was to investigate if undergraduate students enjoy the way in which their laboratories are managed and if students find laboratories' contribution to their understanding and achievement in physics meaningful. Thus, the research questions follow: (1) "what are the undergraduate students' views about the effectiveness of the physics laboratories?" and (2) "what are the problems about physics laboratories that undergraduate students suffer from?" This was a quantitative study including the responses of 216 freshman and sophomore students, who took introductory physics laboratory courses in one of the universities in Turkey, to a survey developed by the researchers in order to seek answers to the research questions mentioned above. The survey consists of 46 Likert type items, 2 multiple choice questions, and 7 items constructed in semantic differential type. The items were constructed carefully by reviewing the literature, making interviews with students before the pilot test of the initial version of survey with 98 participants. The results indicated that the students are mostly satisfied with their laboratory experiences which is in agreement with the conclusions of the previous studies (Deacon & Hajek, 2011; Hanif, Sneddon, Al-Ahmadi, & Reid, 2009; Sneddon, Slaughter, & Reid, 2009). However, the participants would like to have a lab partner, because they think that having a partner contributes to their learning. In addition, the participants believe that having more assistance from lab instructors would be helpful for their learning and achievement in these lab courses. Based on these results, it appears that the interactions among students and between students and the instructor during the laboratory sessions with different instructional arrangements or opportunities need to be increased to improve students' learning in the physics laboratories. Moreover, many students (87%) believed that the physics laboratory experiments should be in alignment with the theoretical section of the course. Surprisingly, the students were pleased with the cookbook lab implementation. Apart from the main focus of this study, it came out that the participants of the study prefer following the procedures blindly, without understanding the theoretical background. This finding could lead the reader to question the willingness of the students to learn. Keeping in mind that the current design of the university physics laboratories in Turkey is very similar to the physics laboratory courses in the university under discussion, it can be inferred that the designs of these laboratory courses should be reconsidered by taking into account these students' reflections concerning the physics laboratories.

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Keywords: Physics laboratories, students' perceptions of physics laboratories, undergraduate students

P1.G05.09
Strand 7: University Physics
Poster Session - 1.05
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Comparing different teaching approaches about Maxwell's displacement current

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Maxwell's insertion of the displacement current term in Ampere's law is beyond doubt one of the greatest achievements of the human mind. It was a crucial step for the prediction of electromagnetic waves that led to the unification of electromagnetism and optics. From an epistemological point of view, it also represents a major innovation in physics' methods, since the term is deduced within a pure theoretical reasoning instead of being the mathematical representation of empirically observable phenomena.
Due to its relevance, the teaching of the displacement current is one of the most important topics of any course on electromagnetism. However, there are many possibilities for justifying the need for this term, which emphasize different aspects and encompass different views of the nature of science. In order to investigate these differences more deeply, we have analyzed four physics lectures on this topic, which were given by four different lecturers in undergraduate introductory level courses. Based on the analysis of these lectures and the historical/philosophical literature on this issue we propose a set of five criteria for comparing the lectures, which are briefly described in the following:
1) Compatibility with the continuity equation
It is analyzed if the incompatibility between Ampere's law and the charge conservation principle is mentioned. In a deeper level, we are also interested in seeing how this inconsistency was presented and solved (e.g. integral or differential formalism).
2) Symmetry of the field equations
One possible justification to the introduction of the displacement current term is related to symmetry arguments. Therefore we observed if these arguments were mentioned in the lectures and how they were justified.
3) Charging capacitor problem
The charging capacitor problem is "pedagogically irresistible" when teaching about the displacement current. We analyzed its role in each lecture (e.g. introduction or application) and the way it was solved by the lecturers.
4) Philosophical discussions about the theory-experiment relation
This historical episode is very suitable to motivate deep discussions about the nature of physics, especially concerning the theory-experiment relation. We investigated if these kinds of discussions were present in the lectures and how they were conducted.
5) Reference to Maxwell's reasoning
Both Maxwell's original works and historical papers show that Maxwell's own reasoning followed intricate paths and used mechanical models as analogies; so that it is very hard for us to grasp what he actually did with the tools available today. In this sense, one should be careful when attributing to Maxwell things that were developed after him. We analyzed whether the lecturers were aware of this fact or if they inadvertently used expressions like "Maxwell did that" in the lectures.
In this work we present a synthetic analysis of four lectures according to these five criteria. Our goal is to provide enough arguments to foment the debate about what would be the possible "ideal lecture" on this topic. We have also analyzed each one of the lectures with the software Videograph and a set of categories (presented elsewhere) to examine of the role of mathematics in physics instruction. The timelines plotted by the software provide visual representations of the considerable differences between the lectures.

Keywords: Displacement current, Physics lectures, Comparative study

P1.G05.10
Strand 7: University Physics
Poster Session - 1.05
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Transparent anisotropic materials in monochromatic and white light

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An anisotropic material is birefringent and consequently one ray of light splits into two rays with different polarization after passing through it. Because the two polarizations have different phase velocities, the phase shift results in elliptical polarization. Using polarisers, one detects variation of intensity of light for different elliptically polarized states. A confusion arises, when the white light is used instead of monochromatic illumination. In that case, the transmitted light is coloured. We present a set of experiments to suppress this confusion.
The experiments are based on anisotropic materials (transparency or some layers of scotch tape) between two crossed polarisers. To illustrate the problem, students are illuminating the sample with a monochromatic light (laser beam) and the whole spectrum of wavelength (white light). They observe with naked eye (or, in the case of a laser beam, with the photodiode) the change in intensity of the transmitted laser beam and the colour changes when illuminated with white light, while they are changing the thickness of the sample and the angle of incidence (observation).
To understand and clarify the problem, why they see colours in the case of white light illumination, they measure the spectra of transmitted light. They observe also the colours and relate them to the spectrum changes, while rotating one of the polarizer. The experiment shows students that different wavelengths become differently polarized and consequently differently absorbed [1].
For an additional experiment, students can observe the conoscopic figures of the same sample with lasers with different wavelength and with diffused white light. They can observe the difference in the distance between minimums and maximums of intensity of the pattern while using different monochromatic light sources and the mixture of the monochromatic patterns while using white light.
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Keywords: Anisotropic material, monochromatic light, white light

P1.G05.11

Strand 7: University Physics

Poster Session - 1.05

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Mechanics Online: Introductory Physics Course Focused on Problem Solving

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We have launched the Mechanics Online Course (http://relate.mit.edu/physicscourse) developed by MIT's REsearch in Learning, Assessing, and Tutoring Effectively (RELATE) group and hosted on the LON-CAPA course management platform (http://loncapa.org). The course aims to develop better problem solving skills by engaging student with the Modeling Applied to Problem Solving Pedagogy (MAPs). In MAPS, students are trained to spend more time planning a strategy to solve problems by thinking about the possible systems and interactions to consider and explain which physical "Model" best applies in the given physical situation [1]. The Models in MAPS are instructor generated, and they align with the topics found in a standard college mechanics syllabus. Students employing the MAPS pedagogy showed significant improvements in their problem solving skills, attitudes towards learning, and on performance in subsequent courses [1, 2].
Within the online course, chapters and modules are organized by learning objectives that feature electronic text, animations, videos, and worked examples. The course contains hundreds of assessment items, some used as "Check Points" to gauge a student's understanding of a single concept discussed in the material, and others as homework to be finished at the end of each chapter. Homework problems are classified into "easy", "medium", and "hard" problems, where more difficult problems are weighted higher in points. Students choose the level at which they work problems and are required to achieve a certain number of points in order to acquire full credit [4]. The majority of these problems and their categorization are based on results from physics education research [3]. The content of the course is made available through the loncapa network, and teachers can choose components of the course to use in their classes.
We present the course structure, and report on the results from the first implementation. In addition to offering the course for free online, we have used the content to teach a section of introductory physics in a flipped classroom at MIT. We compare the student's performance in the online offering to the MIT course, and use that to motivate our planned implementation of Item Response Theory in LONCAPA network, enabling universal grading of the students that is independent of which school they go to, or what problems they work. We are looking for users and collaborators.

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Keywords: Pedagogy, Introductory Physics, Problem Solving, Online Education

P1.G06.01

Strand 8: Initial Physics Teacher Education

Poster Session - 1.06

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Hidden elements influencing the teacher candidates' ideas about concept mapping

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The concept maps were used firstly by Novak (1990a) at the college level to help students' meaningful learning of subject matter in science and mathematics. They represent the concepts of a topic by effective graphical tools and also connect the concepts meaningfully in the form of propositions (Novak, 1995; Novak & Gowin, 1984, p.15; Novak & Canas, 2008). Concept maps outline the major points of the topics in a systematical way; they make key ideas clear for both teachers and students (p.15), and give opportunity exchange ideas and foster cooperation between teacher and students (Novak & Gowin, 1984, p.23). So, they can be used in science instructions by teachers for different aims in each period of instruction; such as instructional planning (Novak, 1990b; Novak 1995), advance organizer in the exploration of students' prior knowledge (Willerman & MacHarg, 1991), in the exploration of students' misconceptions (Novak, 1990b) and as an assessment tool (Kaptan, 1998; Kaya, 2003; Novak, 1990a).

In this qualitative research, we have examined the teacher candidates' ideas about the concept mapping. Two groups (each group with four teacher candidates) of teacher candidates from two universities participated in the study. The data were collected via interviews. Video records were transcribed and the concept maps (drawn during the interviews) of each participant were matched with his/her interview transcript, and then the data were coded. The results showed that, although most of the participants in this study thought that concept mapping is an effective tool to teach physics, they believed that there are some elements influencing the usage of the concepts maps. In other words, we identified that the teacher candidates were not enthusiastic about the use of concept mapping varied for some reasons such as language, limitation in the assessment, limitation in the expressions, teacher's knowledge. In addition, because of being inappropriate with Turkish language structure well, although they know concept mapping, they had difficulty in mapping.

Keywords: concept maps, teacher candidate, physics educaiton

P1.G06.02
Strand 8: Initial Physics Teacher Education
Poster Session - 1.06
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Integrating multiple modes of representation into physics teacher education through digital video analysis

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This poster presentation will present preliminary research that explores preservice physics teachers' current positioning within, and projected future use of, multiple forms of representation through infused technology within the physics classroom. This is accomplished through the overlapping integration of the symbolic, numerical, graphical, and visual modes of representation demonstrated with the use of Ipad technology and the digital video analysis of an ice hockey "saucer pass".
The province of Manitoba, as indicated in the recently released results of the Pan-Canadian Assessment Program (PCAPs) and the Programme for International Student Assessment (PISA), ranked near or at the bottom of Canada's provincial rankings in terms of student achievement and understanding of science. Research suggests that effective use of multiple modes of representation in the teaching of physics enables students to develop deeper conceptual understanding. Classroom activities aimed at the successful integration of technology to improve teaching and learning are necessary to help reverse this trend.
With the availability and accessibility of modern technology and hand-held probeware for classrooms increasing, so too has the integration of the Ipad within physics education. This poster focuses on preservice physics teachers using the Ipad, specifically the Video Physics application developed by Vernier, with secondary level physics students to incorporate different modes of representation of physics phenomena. With a general trend towards getting students mobile in the classroom, multi-purposed hand-held science probeware and equipment that enable data collection, display, and analysis are becoming increasingly valuable.
Preservice physics teacher education courses are the home of transformative experiences aimed towards developing teacher identity, efficacy, pedagogical strategies and decision-making through the context of K-12 physics concepts and curriculum. Within these courses, insight into best teaching practices that evoke meaningful learning suggests that inclusion of explicit integration of complementary modes of representation of physics phenomena, concepts, and data, be an explicit part of physics teachers' pedagogical approach.
A significant accomplishment of the project is the activity's ability to combine practical classroom ideas with instructional design. In using the Ipad, and then following it with Logger Pro, students are exposed to four different modes of representation of the physics used in the saucer pass, namely: visual, numerical, graphical, and symbolic. In being cognizant of different student learning styles and cognitive theory, the integration of numerous modes of representation of physics phenomena is critical to facilitating and engaging more students in meaningful and authentic learning experiences. Therefore, science educators must learn to successfully implement multiple modes of representation effectively when making pedagogical choices.
This activity can be used in the classroom setting by teachers who carefully construct and plan their curriculum to expose students to multiple modes of representation towards providing students varying opportunities to learn. As well, divisional and provincial science curriculum coordinators can learn to incorporate these types of activities into the professional development opportunities provided to their staff members through effective modeling of high-level, technology infused, multi-sensory learning techniques aimed at improved teaching and learning.

Keywords: Physics teacher education, technology integration, digital video analysis, saucer pass

P1.G06.03

Strand 8: Initial Physics Teacher Education

Poster Session - 1.06

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Fostering understanding of basic electricity concepts by integrating the teaching-experiment methodology into pre-service teacher training programs

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The study investigated the dynamic changes in the conceptions of simple electric circuits of prospective teachers for primary and secondary schools as well as primary school children. Based on Ausubel, the most important factor influencing learning is what the learner already knows. Typically, for ascertaining, what a student already knows has been done using the clinical interview developed by Piaget. On the contrary to the clinical interview, which aims to understand students' current reasoning patterns without attempting to change them, the teaching experiment incorporates three components: modelling, teaching episodes and individual or group interviews. The research in this study was guided by a teaching-experiment design including peer tutoring between pre-service teachers for primary and secondary schools. Learning and development of conceptual understanding of electricity concepts were expected as a result of three-tiered teaching interventions and interactions between prospective teachers, the researcher who acted as a teacher and the primary school children. Tier 1, at the student level, aimed at investigating the nature of students' developing knowledge and abilities. Tier 2 focused on prospective teachers' developing assumptions about the nature of changes and the development of students' coherent understanding. Tier 3 concentrated on researchers' developing conceptions concerning models to make sense of prospective teachers' and students' modelling activities, focused on promoting the progression of more scientific concepts in basic electricity and examining the primary school children's reactions to specific teaching interventions. Twelve future secondary school teachers, 24 future primary school teachers and 42 primary school children of grade 4 participated in a 6-week project. At first, the teaching-experiment methodology was used with the twelve prospective secondary school teachers comprising a 3-hour teaching episode for exploration, introduction and application of basic electricity concepts. After that, each of these twelve people accomplished a 3-hour peer tutoring session with two future primary school teachers intending to explore the initial peers' conceptions of electric circuits and supporting them to develop a coherent understanding of basic electricity concepts. Finally, the future primary teachers conducted a 2-hour teaching-experiment, where two to three future teachers worked in 9 groups with 4 to 5 primary school children. The interactions of three groups were video-taped, those of further two groups were audio-taped and in each group one person was engaged as observer. Data analysis suggests that the teaching strategy as well as the practical activities used in the study were effective in promoting primary school children's understanding of basic electric circuits. Moreover, the results of the study recommend implications not only for teaching but also for teacher education. Opportunities to conduct interviews with students about their understanding of concepts being taught, or to engage in peer interactions, could be incorporated within teacher training programs in order to develop increased sensitivity to student learning difficulties. In conclusion, the study provides evidence that an effective teacher has to investigate how the students interpret a problem during the process of teaching. Accordingly designed courses in teacher training education can contribute helping future teachers to clarify students' initial conceptions and to evaluate interventions for their effectiveness in aiding students to build an understanding of concepts in different disciplines.

Keywords: Fostering understanding of basic electricity concepts, teaching-experiment methodology, pre-service teacher training programs, primary school children, future physics secondary school teachers, future primary school teachers

Reception study of a video produced as a physics didactic laboratory activity

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High school physics laboratory is a recurring Physics Education research topic. There is a large variety of investigations on physics laboratory, from its specific goals for different types of laboratory to the epistemology involved in experimental activity by students. Nevertheless, Physics Education has barely questioned and investigated the specificity of audiovisual resources when they are involved in teaching and learning processes. Thus, this is part of a doctoral research which seeks to understand how reception of a videos made for high school students is determined and/or conditioned by cultural elements. The theoretical and methodological framework concerns the filmic analysis (Vanoye e Goliot-Lété, 1994) and the reception-production of videos (Hall, 1973; Schrøder, 2000). The filmic analysis is focused not only on the audiovisual text, taking also into account the production context, trying to identify its influence in the composition of the text. Analyzing a film is deconstructing it into parts and then rebuilding it. The reconstruction can support a preferred reading that, in return, may influence the spectators' readings, but not determine them. Schroder extends the Hall's model for reception studies and proposes a multidimensional model, which considers dimensions that can be divided into two groups: (i) readings (related to the internal processes of meaning production in a given context and by a particular spectator, namely: motivation, comprehension, discrimination and position), (ii) implications (related to the social significance of the readings as resources for political action, namely: evaluation and implementation). In this study we analyzed two dimensions: comprehension and discrimination. The first dimension is related to how spectators understand the audiovisual material, influenced by macro (gender, class, ethnicity etc.) and micro (education, culture etc.) factors. The second one is related to the spectators' familiarity, aesthetic and cultural, with: audiovisual material genre, production process, style, etc. The video analyzed is titled "The case of the bent straw". It was produced by five high school students from a public school in Rio de Janeiro and it shows the light refraction in about 5 minutes, including the staging of a TV newscast. The video reception study was conducted with seven other students aged between 16 and 19 years old. Results show that, in general, students focused their readings in the scientific aspects rather than in the aesthetic aspects presented in the video. Reception studies like this may bring knowledge about the characteristics and specificities of teaching and learning with audiovisual resources, since they may identify dynamics of appropriation and resistance to the material used. This research is expected to contribute to the Physics Education area taking into account the adoption of video and communication theoretical frameworks, since these theories are not frequently used by researchers, even when pore over how to make and/or watch videos.

Keywords: video, filmic analysis, reception study, physics didactic laboratory

P1.G07.02

Strand 14: Socio-cultural Issues

Poster Session - 1.07

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Universe hitchhikers: Designing and enacting astronomy-based curriculum in a Brazilian suburban middle school

Daniela Borges Pavani[1], Fabiane Borges Pavani[2], Daniel Flach[1], Felipe Selau[1], Izadora Fontoura[1], Josiane De Souza[1], Marco Vargas[1], Paulo Lima Junior[1], Priscila Chaves Panta[1], Rafael Acker[1]
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This abstract reports a school wide project named 'Universe hitchhikers' which arises from collaborative bounds between one of the most qualified Brazilian universities and a Brazilian suburban middle school. This project has been developed to design and enact Astronomy-based multidisciplinary curricula for science and non-science subjects. This project's approach is also consistent with some major goals found in the CTS movement (García, Cerezo and López. 'Ciencia, tecnología y sociedad'. Madrid: Tecnos, 1996) and sociocultural perspectives to science education (Stetsenko. 'Cultural studies of science education', 3: 471-491. 2008).

Designing an astronomy-based multidisciplinary curriculum leads to the question of how to relate astronomy to other science and non-science disciplines. Actually, it should be highlighted that astronomy does not consist of observing a static Universe – for the Universe is ever changing and its observation lately involves its transformation (for planting space probes, for example). Hence, for the purposes of this project, which is intimately related to empowering suburban students to transform their own (social, political, environmental) context, we focused on three major questions: (1) How is Universe and which is my place in it? (2) Has the Universe always been the same? What changes in it? (3) How do we participate in the transformation of the Universe? Once we understand that each school discipline contributes to answering these questions in their own fields, Astronomy's contribution for designing the multidisciplinary curricula is straightforward.

Most students to which this project has been implemented presented school success below expected due to being previously exposed to (sexual, emotional, physical) harassment and crime. This project's first observable achievement has been to transform classroom environment itself. Before the project, students have been used to reproducing in classroom the social situations of harassment – which they experiment on the streets and within their family. Through collectively studying astronomy and questioning their 'place' in (natural and social) universe, they found a way to enact more collaborative relations.

Finally, this case demonstrates that astronomy's orientation toward observing/transforming the universe has the potential for changing children's own perspective on the (natural/ social) universe around them.

Keywords: middle school, astronomy, curriculum

P1.G07.03
Strand 13: Philosophy, Nature, and Epistemology of Science
Poster Session - 1.07
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

The heuristic algorithms based on metaphors in physics education

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Gazi University

The goal of this paper is to present a theoritical framework explaning the role of heurictic algortims that are based on metaphors in physics. In recent years, various heuristic optimization methods have been developed. Many of these methods are inspired by swarm behaviors in nature (Rashedi, E., Nezambadi, H., Saryazdi, S., 2009). In this study, we will focus on algorithms that are based on metaphors.
�even“Heuristic” means �either“to know”, “to find”, “to discover” or “to guide an investigation” (Lazar, A., Reynolds, R.G., 2003). "Heuristic" is used when an entity X exists to enable understanding of, or knowledge concerning, some other entity Y. An algorithm is defined as a step by step approach for solving a problem. Stories, metaphors, etc., can also be termed heuristic in that sense. Heuristic algorithms have a stochastic behavior. However, Formato, has proposed a deterministic heuristic search algorithm based on the metaphor (Formato 2007, 2008).
In a swarm based algorithm, each member executes a series of particular operations and shares its information with others. These operations are almost very simple, however their collective effect, known as swarm intelligence (Dorigo et al., 1996); produce a surprising result.
1905
Between 1905 and 1925 Einstein used his "method" entirely within the real of thermodynamics and molecular statistical mechanics. A fine example of this is his "Heuristic Viewpoint". According to this point, he argues that (Klevgard, 2008):
" The entrophy decrease of radiation compressed in time and molecular quanta compressed in space suppurt the conlusion that radiation is composed of discrete energy quanta."
The method of analysis that Einstein used within thermodynamics can be extended to areas that he did not cover. Specifically, his method can be applied to an ontological inquiry into the problems raised by quantum mechanics (Klevgar, 2008). Ontology is important because the great questions of physics revolve around what exists and occurs. We will argue that "Heuristics"'s advantages and disadvantages in Physics education. We can find "Heuristics" in every areas in physics. More researches on this idea is needed.
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Keywords: heuristic algorithms, metaphors, physics education

P1.G07.04
Strand 12: History of Physics
Poster Session - 1.07
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

ANATOLIA: the land where Sicience was born and flourished

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Public takes it philosophical roots from the ancient Greek Philosphy.Thales First characteriation of substance to Demokrotius clarification the nature as undivided atoms..The Greek Philosophers always develop their own nature Philosophies.Until 18th.century,physics had been know as the philosophy of nature. After 19th century,physics was separated from the other sciences and philosophy as a positive science.
How many people were aware of the fact that they were arriving to the geographical land where the foundadions of physics were laid,while they were coming to the WCPE congress from all around the world?
How many of people knew the facts like electricity came out by rubbing an amber bar on animals clothing or amber means electra in Greek and electro in Latin or Magnetism emerged when the sperherd Magnesia's feet attracted the stones under his feet,or a pair of compassed emerged due to Apollonius who was from Perge.All these events originated from Anatolia!
Our goal is to make known that anatolia and its surrounding area is the land in which the foundation of physics and mathematics were established.
In our presentation,we are going to divide Anatolia and surrounding in regions and introduce the scientist who were grown up in these regions,with their short biographies and studies on a website.Using the flash programme and the mouse when click on the region the cities are going to be shown upand after clicking on the cities,the scientist their biographies and studies are going to be on the screen.
Miletus; Thales,Leukippus,Demokritus,İsidoros, Anaksimandros
Sisam; Pisagor,Aristorkhos
Perge;Apollonius
Urla;Anaksagoras
Sinop;Diyojen
İzmir;Homeros,Ksenofones
Halikarnassos;Herodot
Tralles(Aydın);Anthemius,Alexander
Fenike(Sayda,Sidon) Zeno of Sidon
Diyarbakır; El Cezeri
Basra;İbn-i Haysam
Efes;Heraklitos
Niğde;Apollonius,Filostratus
Knidos;Eudoksus,Euryphon,Polygnotos
Bergama;Apollonius
Midilli;Theophrastus
İstanbul;Filyon of Bizantiyon, Akşemsettin,Piri Reis,Uluğ Bey,Matrakçı Nasuh,İbrahim Efendi,Cahit Arf,Lagari Hasan Çelebi
Ali Kuşçu,
Mezopotamya;Sümerler
Our Colleagues visit İstanbul for WCPE Congress from the different parts of the world will realize that they also arrive at the cradle of science.
Anatolia has been home to those who have different religious and cultural values for ages.
People that belong to separete religion,society and nations came together in the light science.
After the Congress,Our Collegues who will have arrived at their own countrience with their colleagues and students.
This is the land where a lot of scientists were born and it will always make us remember the value of science.
Wcpe Congress will be helpfully to inform all the people on the world about the significance of Anatolia..
Moreover,we will get a chance to show our respect to those who have flourished science on the land.
In conclusion,a random person who lives an a different place on the world will have a chance to learn more about the short biography and study of a scientist who has lived in a Anatolia and its surrounding lands.

Keywords: Emergence of Science, Anatolia, Thales, Magnesia, Miletus, religion, science & society

P1.G07.07

Strand 12: History of Physics

Poster Session - 1.07

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Teaching Materials along with History of Science – Electricity and Magnetism –

Masako Tanemura

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It is expected that carrying out the experiment along with the discovery of electricity and magnetism, which is famous on the science history, can bring us educational effect. Some processes in which scientists discover and recognize strange phenomena are similar to some processes in which students acquire knowledge.
Volta studied the "animal electricity". He realized that the frog's leg served as a detector of electricity. He invented the voltaic pile, an early electric battery, in 1800. When Hans Christian Orsted experimented by Voltaic pile, in 1820, he discovered that electric currents induce magnetic fields. Till then, electricity and magnetism had been regarded as different phenomena. He discovered an important aspect of electromagnetism. Faraday predicted an opposite phenomenon which electric currents might be obtained from magnetic fields. One year after, Faraday made his electrical motor. And ten yeas later, Faraday discovered the electromagnetic induction. Arago discovered the phenomena of rotary magnetism. The discovery was completed and explained by Faraday. He also built the generator of the first electromagnetism called the "Faraday disk" by this elucidation. With the development of electromagnetic induction, our life style of that time was replaced by the modern one that utilizes electricity.
Most students of our university become a teacher of an elementary school. However, they have little interest in physics. It is expected that these teaching materials will attract students. I created historical experimental device which are able to make easily and low-cost. When a student becomes a teacher, he (or she) can make them by himself (or herself). These experiments are introduced on Web. You can see video clips and description of historical experiments.
It can encourage us to comprehend electricity and magnetic phenomenon easily, to find the scientists' point of view and to know how much science benefits our daily life.

I would like to show some teaching materials.

Keywords: history of science, teaching materials for experiments, teacher training, attractive to students.

P1.G08.01

Strand 16: International Perspectives

Poster Session - 1.08

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

The role of the 21st Century Science syllabus in promoting the interest of non-science students in Physics: A case study in the island of Mauritius

Sarojiny Saddul Hauzaree
Mauritius Institute of Education

The University of Cambridge 21st Century Science GCE ‘O’ level syllabus was introduced in the context of broadening the secondary curriculum base of all students at Form IV and V in Mauritius. The introduction of this science syllabus as a compulsory subject for non-science students was introduced on a pilot basis in fourteen project schools. It was meant to promote scientific literacy amongst secondary school students not opting for a science subject at secondary level. The curriculum content is in modular form and consists of several modules in physics, biology and chemistry. The syllabus was introduced for the first time in January 2009 and the first cohort of students completed the course and took part in the Cambridge School Certificate examination in November 2010.

Over the years there has been a sharp decline in the number of secondary students who study physics as a separate subject at school level. For science students who willingly choose physics as a subject, their main interest in learning physics is linked to their option for a career path in science and engineering. Most studies try to understand the factors that stimulate and promote the interest of science students in the learning of physics. There is a paucity of research on what promotes the interest of non-science students to learn science, and in this case, physics. It is often perceived that non-science students show a lack of interest in learning science just because they have not opted for science. The completion of this pilot project on 21st Century Science GCE ‘O’ level syllabus offers a unique opportunity to understand what promotes the interest of non-science students to learn physics in a formal school curriculum and how to further engage them in learning physics outside the school curriculum. We report the results of a study on non-science student interest in physics at the completion of the 21st Century Science GCE ‘O’ level syllabus.

It is our goal to study and examine the role of the new 21st Century Science GCE ‘O’ level syllabus in promoting interest in the study of physics amongst non-science students. One method for accomplishing this is to study to what extent the attitudes and expectations of students following the new syllabus, the content of the syllabus, the teaching methods for the syllabus and the learning experiences of students influence non-science student interest in learning physics as a science discipline.

The study starts with a description of the aims of the syllabus, assessment objectives and curriculum content. A total of ten schools secondary schools acting as pilot schools for the project, hundred and fifty-two students who completed the two-year course and teachers who taught the classes participated in this study. A survey instrument is used with teachers involved in the project to find out how the syllabus is taught and learned in schools and the type of learning activities students experience. A student questionnaire is designed and administered to examine student attitudes towards physics and expectations in learning physics. One-to-one interviews were conducted with a sample of students chosen from different schools across the island who have completed the 21st Century Science course to determine the role of the new science syllabus in promoting their interest in physics. Factors studied were their opinions about the classes, student-centered activities in which they participated and their different learning experiences in physics inside and outside the science classroom.

The findings show that several factors contribute to promoting their interest in physics learning while following the science course. It is seen that direct and explicit teaching strategies greatly influence the interest of students in physics and hands-on activities and laboratory, with less guidance from the teacher, tend to decrease their interest in physics. Many students felt that the topics of the syllabus were not very relevant to their everyday life experiences and their poor background in science was mostly responsible for them losing interest in physics learning.

This study shows that the relevance of the physics students learn and the teaching techniques greatly influence the interest of non-science students in physics. The attitudinal constructs and the expectations of students in learning physics, as fundamental and thus not to be neglected, are however not determining factors in stimulating their interest in physics. Based on the findings of the study we propose several recommendations to improve the teaching process of 21st Century Science to promote the interest in physics at the school level amongst non-science students. Based on the research findings, we propose a revised syllabus which is contextual and hence more relevant to students in Mauritius.

Keywords: 21st Century Science, interest in physics, non-science students

P1.G08.02x

Strand 16: International Perspectives

Poster Session - 1.08

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

The effect of incorporating indigenous knowledge related to Physics concepts into Grade 9 science curriculum on the attitudes of students in Chókwé, Mozambique

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For some time there has been general concern that the number of students interested in studying Physics has been dwindling. Various curriculum initiatives worldwide have been designed to try to pique students' interest. In the developing world, there is concern that urbanization and westernization may lead to the loss of indigenous knowledge and technology (IKS). In order to both help preserve IKS and increase students' interest in physics, we designed a two-part study. Part one, reported previously [1], comprised interviews with senior citizens from a rural area of Mozambique, Chókwé, in order to identify aspects of their IKS that could be linked to physics concepts. Part 2 comprised the design and implementation of physics curriculum incorporating information gained from the interviews, together with pre and post tests of students' attitudes and content knowledge. In this paper we shall report on the effect of the teaching intervention on students' attitudes.

The sample comprised 275 Grade 9 pupils from Ngungunhane Secondary School in Chókwé, the same region in which the interviews with senior citizens were conducted. Grade 9 pupils were chosen because this is the grade in which they study thermal physics, one of the topics for which physics-related IKS had been identified. The first author taught the pupils the thermal physics section of the curriculum himself, using inquiry-based materials he developed that incorporated relevant IKS examples identified from the interviews.

A questionnaire soliciting pupils' attitudes towards physics was administered before and after the teaching intervention. The questionnaire comprises nine questions with both a 5-point Likert scale part and an open-ended part. It was based on an instrument that had been validated and used in similar investigations [2]. The reliability factors of the instrument were tested using Cronbach's Alpha, which was 0.70, and a peer correlation value of 1, meaning that both the questionnaire and pupils' responses are valid.

Large differences were obtained on several questions from pre- to post-test. The number of agree and strongly agree responses went from 178 to 234 on the question, "Physics is related with my own everyday life"; 198 to 219 for, "I find physics interesting"; 119 to 178 for, "It is possible to explain physics ideas without mathematical equations"; and 115 to 168 on, "I like to discuss physics with other students." Results suggest that the teaching intervention, which integrated IKS into curricula and used a guided inquiry approach, improved pupils' attitudes towards physics.

[1] Baguete, A.M., Grayson, D. and Mutimucuio, I.V. (2009). Probing indigenous knowledge related to Physics concerts amongst senior citizens in Chokwe, Mozambique. Presented at the International Conference on Physics Education 2009, 18-24 October, Bangkok, Thailand.
[2] Adams, W., K., Perkins, K., K., Dubson, M., Finkelstein, N., D., & Wieman, C., E., (2005). The design and validation of the Colorado learning attitude about science survey. Disponíl to 20 July 2007. http://cosmos.colorado.edu/Phet/survey/classs/Perkins

Keywords: Indigenous knowledge, student attitudes, curriculum

P1.G08.03
Strand 16: International Perspectives
Poster Session - 1.08
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Cooperative physics learning and International Sciences Development in Beregadougou, Burkina Faso

Simon Langlois[1], Zimba Tassere[2], Catherine Malo[1], Jean Pierre Miron[1]
[1]Cégep Marie-Victorin
[2]Lycée départemental de Bérégadougou

For the past two years, the Cégep Marie-victorin and the Lycée départemental de Bérégadougou have worked together to improve sciences learning among the High school students of Beregadougou.
The first step was to instaure a cooperative learning approach by implementing a sciences help center. Voluntary good students help their peers who have more difficulty with sciences learning. With an increase of success at the annual national evaluation (BACC), we consider this type of support as being efficient and cost-free. For countries with low investments in the field of sciences, this could be an interesting way to improve sciences learning in the classrooms.
With the same objective of improving the science formation in the village of Beregadougou, collegue students in Montreal raised money to build a science laboratory. This will allow the Beregalese students to receive, in complement of their theoretical background, a more experimental one.
In this poster presentation, we will discuss how to establish a partnership with a foreign school in a developping country and what were the challenges and successes encoutered during the process.

Keywords: Cooperative learning, International collaboration, sciences curriculum, partnership

P1.G08.04

Strand 17: Various Topics in Physics Education

Poster Session - 1.08

Date & Time: 03.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

The Secure project researches science curricula and teachers' and learners' opinions on science education

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Introduction

In its latest policy initiatives and outputs in education and training the European Union restated the importance of science literacy and numeracy as fundamental elements of key competences [1, 2, 3]. It was recognized that more investment should be undertaken to increase the number of graduates in science, technology, engineering and mathematics (STEM) so as to create the right conditions to deploy key enabling technologies, essential in the R&D and innovation strategies of industry and services [2].

Objectives

SECURE is founded as a collaborative project under FP7 to provide research results of current mathematics, science and technology (MST) curricula across Europe. The overall aim of the SECURE project is to make a significant contribution to the European knowledge-based society by providing relevant research data that prompt public debates on this issues. Based on good practices and other research results SECURE will formulate a set of recommendations for policy makers and other stakeholders on how MST curricula and their delivery can be enhanced. These improvements would need to focus on encouraging and preparing children from an early age on for future careers in MST. At the same time curricula should make MST more accessible and enjoyable for all children so that they will always keep a vivid interest in mathematics, science and technology, understanding the importance of their societal role.

Research

A rigorous research program conducted by the SECURE consortium scrutinises and compares current MST curricula for pupils aged 5,8,11 and 13 in ten member states as they are intended by the authorities, implemented by the teachers and perceived by the learners. The instruments used to this end consist of a transnational comparative screening instrument for MST curricula, of teacher and learner questionnaires and interview protocols. Currently the research in schools is taking place.

The authors will present the research strategy, including criteria for comparison of curricula, questionnaires and interview formats for teachers as well for all four age categories.

Discussion

The cornerstone of the valorisation strategy of the research outcomes is the direct and active involvement of a transnational expert group of research and curriculum development institutions outside the consortium that will provide feedback as well as a direct access to policy makers. Big European projects can benefit from the outcomes as well, adapting their strategy and implementation methods to the results of the research done. Potential candidates for the expert group are invited to consider their participation in the project as external expert.

SECURE project received founding from the European Union’s 7th Framework Program for Research and Development.

References.

[1] Official Journal of European Union C 323/11 (30.11.2010) and references therein. Council conclusions on increasing the level of basic skills in the context of European cooperation on schools for the 21st century.

[2] Agenda for new skills and jobs: A European contribution towards full employment (23.11.2010): http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0682:FIN:EN:PDF.

[3] Official Journal of European Union C 119/2 (28.5.2009). Council conclusions of 12 May 2009 on a strategic framework for European cooperation in education and training (‘ET 2020’).

Keywords: MST education, school level, European program, research in science education

P1.G08.05
Strand 17: Various Topics in Physics Education
Poster Session - 1.08
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

An Analysis of the Potentialities of a Scientific Literature Book on Physics Teaching

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Two theories related to the practice of reading in Brazilian schools are raised by Silva (1998). One refers to the responsibility of all teachers by the formation of readers and the development of the practice of reading in their disciplines. The other says that the creative imagination and the fantasy should not be developed only in literature classes. Themes of physics and astronomy are recurring in popular science books written by scientists themselves, which may allow a greater dialogue between the production of knowledge and its dissemination. In order to understand better some of these books and its possibilities of uses in class, in this work, the one called "George's Secret Key to the Universe" and written by one of the most popular science divulgators nowadays, Stephen Hawking, in partnership with his daughter, Lucy Hawking was analysed. The analysis is based on the work by Ribeiro (2007), developed from Paulo Freire's educational approach and bringing important elements for the analysis of scientific divulgation materials from two perspectives: the characteristics inherent to these materials and the perspective of the formation of readers and critical readers. From this analysis it was possible to identify characteristics inherent in the texts of disclosure, i.e., the use of some resources, such as metaphors and analogies that simplify the language presented in the texts, the form of sensationalistic presentation of science in the story, suggesting a positivist image of science and scientific activity. It is possible to identify some attempts to generate interest in science and provoke feelings of curiosity, emotion and desire in the possible readers, inserting them into the world of science. This is especially presented in the exposition of the main theme of the book, which revolves around the black holes, that is very much highlighted on the cover of the book, calling the reader's attention, and by devoting an entire chapter to this theme in order to inform readers, in a simple way, the concepts needed to understand these cosmic objects. The characteristics of the textual narrative, presented through the simplification of the concepts covered in the course of the adventure, allow the immersion of the reader into the story, bringing it gradually to the understanding of the scientific content, besides the contact with different material from the textbook, what indicates that the book has the potential to be used as a tool to the development of reading skills and the reading habit. However, the stimulation of the critical vision to reality and to the production process of scientific knowledge through the reading of this material is only possible to be developed by the one who mediates its reading, once it was not produced to clarify these ideas to the reader. Thus, some care must be taken by teachers to introduce these materials in their classes, because as we have seen, among other things, the book presents the image of science and overrated stereotypical image of scientists, issues to be discussed by those who wish to take the book as reading material for teaching physics. But despite these limitations, the book indicates a potential use as a means to educate scientifically, contributing to the important task of taking students to the world of imagination and creativity by reading a scientific adventure filled with contemporary content of Physics and Astronomy.
Ribeiro, R. (2007). Divulgação científica: funções, intenções e vertentes. Master's thesis. Universidade de São Paulo: Brazil.
Silva, E.T. (1998). Ciência, Leitura e Escola. In: Linguagens, Leituras e Ensino de Ciências. Mercado das Letras: São Paulo. 105,112.

Keywords: scientific publicizing, non-didact text; reading in physics classes;

P1.G08.07
Strand 17: Various Topics in Physics Education
Poster Session - 1.08
Date & Time: 03.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Implementation of a teaching-learning sequence about greenhouse effect: How to take into account teachers' points of view?

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[2]Département de Physique, Université Paris Diderot, Paris, France

Our study concerns the design of a teaching-learning sequence about greenhouse effect. In the framework of "Educational Reconstruction" and "Didactic Engineering" we have proposed guidelines based on an in-depth analysis of the science content and on students' difficulties. Greenhouse effect is a very complex phenomenon which encounters a wide array of difficulties which one in particular is to combine changes in temperatures relating to energy exchanges and construction of energy balances with respect to energy conservation. These difficulties are mainly related to the so-called sequential reasoning.
Many studies have revealed that teachers are not only passive transmitters but are very often active transformers of the TLS designers' intentions. Therefore, for a successful TLS implementation, it is worth to take teachers' points of view into account when designing. This presentation is focused on this part. To have an in depth analysis of teachers' reactions, we have chosen to conduct semi-structured interviews about one hour and twenty minutes long. Many factors have been selected to build our teachers' sample (N = 19): novice or experienced, having taught or not greenhouse effect, discipline (Earth and Life Sciences (ELS), Physics Sciences (PS)), teaching level (high school, university). The first stage of the protocol relies on an open questioning to explore their scientific vision of the greenhouse effect and global warming (phenomenological description and modelling) and their teaching strategies. The second stage is a discussion supported by excerpts of textbooks and popularization documents (books and websites) relating to energy balances. We focus on teachers' reading of the images: are they facilitator or obstacle to their understanding? How would they use these images in teaching?.
Our main result is a common trend: a large majority of interviewed teachers encounters difficulties to deal with energy balances. These difficulties may be to some extent comparable to those observed among students: sequential reasoning is very present, often reinforced by images' elements. ELS teachers interviewed have more difficulties than PS teachers. But we have to be careful not to generalize too fast because it is an ELS teacher which reacts most quickly to a diagram showing a balance totally inconsistent with energy conservation. This common trend apart, we notice some elements related to specific factors. ELS teachers hardly accept, sometimes reject, quantified energy balances, even in a very simplified version. We notice resistance from ELS experienced teachers to change their strategy even if a learning progress could be expected. Modelling atmospheric greenhouse effect by a greenhouse is often rejected by ELS teachers who have already taught this phenomenon, for two reasons: first, they are aware of the well-known students' confusion between greenhouse effect and ozone depletion, secondly, they often misunderstand the absorption-emission phenomena both in the greenhouse gases and in a glass-pane. Although the limited duration of the interviews, we notice among the interviewed teachers some clarification of concepts and phenomena involved, in particular the need for a clear distinction between the transient and steady state situations, taking into account instantaneous energy balances and simultaneity of exchange between different systems involved.
During the last stage of the interviews, we asked teachers about their feelings after the discussion in order to know if they became aware of the possible evolution or change in their ideas. In their comments, two points should be highlighted: teachers' awareness about the difficulty to explain temperature's rise or constancy according to energy balances; secondly, teachers' awareness about images' reading and use in teaching. In particular, some teachers expressed spontaneously the need for at least two clear-cut images to illustrate respectively the transient situation and the stationary situation, which is totally consistent with our approach.
These results contribute to adapt the design of a TLS on greenhouse effect according to teachers' discipline (ELS and PS) and to plan teacher training sessions.

Keywords: greenhouse effect, textbook, scientific popularization, image, sequential reasoning, energy budget.

PS.05.01.a

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 05.01
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D501 (4th Floor)

Exploring the rolling shutter effect using a computer scanner

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It has been shown that integration of everyday objects and modern technology into a physics curriculum has a positive impact on motivation and appreciation of science among students. Using objects or gadgets that are widely available to students encourages their active engagement by exploring physics behind these objects and thus make physics part of their everyday life. Nowadays, almost every mobile phone has its own digital camera with a CMOS light sensor. These sensors differ from CCD sensors in many ways, one of them being the electronic shutter operation. In contrast to the global shutter usually utilized by CCD sensors, the CMOS sensors typically use a rolling shutter. They capture the image row by row, in a way that different rows of the image are captured in succession at slightly different moments in time. This becomes apparent on photographs of rapidly changing or fast moving objects, where the images exhibit the so-called rolling shutter effect. Similar effects can also be found in photo-finish images of cycling races and in the long-known Roget's palisade illusion. We will observe and explain why images of rapidly rotating objects, such as airplane propellers, bicycle wheels, or cooling fans exhibit such strange patterns, when captured with a rolling shutter camera. We will also show that the photo finish effect and the Roget's palisade illusion are very similar and can be considered a special case of the rolling shutter effect. A student activity will be presented in which a computer desktop scanner is used to simulate a rolling shutter camera image capturing sequence. This activity allows students to manipulate the scanning rate and the rotating velocity of a slowly rotating disk with drawn radial lines. This enables them to make a transition from a slowly to a fast rotating disk and observe and analyze the corresponding image patterns. In order to understand and explain different patterns, we must address topics that are part of a typical high school physics curriculum such as relative motion, vector addition and relationship between tangential and angular velocity. The presented example offers students a chance to develop a better sense and a deeper understanding of velocity as a vector quantity.

Keywords: rolling shutter, scanner, relative motion, student project, digital camera, photo finish, Roget's palisade, rotation

PS.05.01.b
Strand 1: ICT and Multi-Media in Physics Education
Parallel Session 05.01
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D501 (4th Floor)

Animations of spacecrafts' flights

Tomáš Franc
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The gravitational assist is a method used for planning and changing trajectories of spacecrafts. A probe flies around a planet or a satellite and changes its direction and speed because of the gravitational attraction of a much more massive body.
NASA maintains a powerful web interface (called HORIZONS) where we can obtain data of all planetary missions which used the technique of the gravitational assist (GA). With these data we can create our own animations of space flights to other planets (for example Pioneers, Voyagers, Galileo, Ulysses and all other missions that used the GA including current missions like Cassini, Messenger, New Horizons, Dawn and Juno).
A suitable program for creating an animation from a list of the data of spacecrafts coordinates is Wolfram Mathematica (WM). WM allows us to create a two-dimensional animation and also three-dimensional which is very useful – we can any 3D graph rotate and zoom – we can study any details we are interested in. And in spite of (static) pictures we can study much more details of the flight like discovering if the spacecraft flew before or behind the planet (that is very important – spacecraft can be accelerated or decelerated).
During the oral session we will present very shortly the NASA web interface, necessary data manipulation before importing into WM, basic WM commands for making animations and mainly some examples of animations. We will also present the ideas how to use it at high schools – one possible approach is to create with students their own animations or to use our completed animations just to study the details of flights (we plan to give our all animations for free, it is also probable that we will try to publish them on Wolfram Demonstration Project).
(A research among high school students is planned but it will be very probably realized after the conference).

Keywords: gravitational assist, animation, spacecraft

PS.05.01.c

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 05.01

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D501 (4th Floor)

Design, implementation and evaluation of three-dimensional models in autocad for the understanding of the maxwell equations in differential form

Angel Antonio Rojas Garcia[1], Sonia Janeth Lopez Rios[2], Juan Pablo Oviedo Roa[1], Ronald Gilberto Marquez Rivera[1], Michael Alexis Parra[1], Dairo Osorio Quiroga[1]

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Physical concepts have Traditionally been difficult to understand for students faced in the process of it is formation on a subject related to the disciplinary field, however, there are some concepts which by their ability to be compared with real referents, maybe more understandable to students, but cannot say the same of those fundamental physical concepts that have a high degree of complexity for your understanding. Specifically, difficulties have been detected for students in the understanding of laws that contain the concept of field and flux, such as: Gauss's Law (Electric and Magnetic Field), Ampere and Faraday's law, but even when they are presented through a mathematical language based on vector and explicit relationships with partial derivatives (equations in differential form). The identification of these difficulties relate particularly to the understanding of the equations and their respective deduction will leads us to contemplate the need to propose strategies and tools that can be implemented in the classroom for the purpose of these topics in Physics become more accessible to our students. Trying to answer the question: ¿ what possible tools can be implemented to provide students with an understanding of Maxwell's equations in differential form?

Based on this guiding question was formulated a proposal aimed at teaching design, implementation and evaluation of three-dimensional models in AutoCad, considered potentially significant materials from the perspective ausubeliana (Ausubel, 2002), for the purpose of addressing the teaching of Maxwell's equations in differential form in a course of Electricity and Magnetism. This proposal was based on the construction of conceptual and theoretical models (mathematical models) by some students of the course, with the continued support of the teacher.

The main results of the implementation of this proposal, valued mainly from a qualitative perspective, show that AutoCad becomes a highly potential tool for working with conceptual and theoretical models, allowing more interactivity from the construction of more complex representations in three dimensional formats. Thus favoring the understanding of physical concepts, specifically those related to Maxwell's equations. Also generate a greater disposition of students to achieve meaningful learning of physics as a field of knowledge. We believe that implementing this type of teaching proposal, are consolidated as a valuable contribution to the teaching of physics concepts that can be perfectly supported whit the use of Information Technology and Communication whit the great growing in the teaching and learning process.

Keywords: Maxwell's equations in differential form, Meaningful learning, Three dimensional models, Conceptual models, Autocad.

Teaching physics and mathematics for earth sciences with computational modelling

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Modern research and other professional activities in earth sciences areas, such as geophysics and meteorology, require advanced knowledge about mathematical physics models and scientific computation methods and tools. Learning such advanced knowledge skills is a difficult cognitive process that progressively brings up a strong background in physics, mathematics and scientific computation that is appropriately adapted to the diverse areas of the earth sciences. At introductory levels, from secondary education to the first two years of university education, earth sciences learning environments should then be based on curricula that involve interactive engagement sequences of computational modelling activities, with computer modelling systems which give students the opportunity to improve their knowledge in physics, mathematics and scientific computation, while simultaneously focusing learning on the relevant earth sciences concepts and processes.
This is an expectation supported by the results of many research efforts (see, e.g., McDermott & Redish, 1999; Slooten, van den Berg & Ellermeijer, 2006), which have been able to show in various contexts that the learning processes can effectively be enhanced when students are embedded in environments with activities that approximately recreate the cognitive involvement of scientists in modelling research experiences. Fundamental for the implementation of these interactive engagement methodologies is an early integration of modelling activities with computational methods and tools, a goal that in particular should be achieved while teaching introductory physics and mathematics for earth sciences courses.
The integration of computational modelling activities can be based, for example, on professional programming languages (see, e.g., Chabay & Sherwood, 2008) or professional scientific computation software such as Mathematica or Matlab. These approaches, however, require students to develop a working knowledge of programming. To reduce such cognitive load several computer modelling systems have already been developed (see, e.g., Christian & Esquembre, 2007; Heck, Kadzierska & Ellermeijer, 2009; Teodoro & Neves, 2011; Wieman, Perkins & Adams, 2008). Among such systems, Modellus (Teodoro & Neves, 2011) is particularly advantageous because it is a domain general system for explorative and expressive mathematical modelling which allows: 1) an easy and intuitive creation of mathematical models using just standard mathematical notation; 2) the simultaneous exploration of images, tables, graphs and object animations; 3) the attribution of mathematical properties expressed in the models to animated objects; and finally 4) the computation and display of mathematical quantities obtained from the analysis of images and graphs.
In this paper, we describe a set of computational modelling activities in introductory geophysics and meteorology developed with Modellus, covering topics such as solar radiation, wind dynamics and seismic waves. These activities were developed for undergraduate university geophysics and meteorology courses involving students possessing only very basic secondary education level knowledge about physics and mathematics and no significant prior knowledge about scientific computation.
Using Likert scale questionnaire data from several courses offered by FCT/UAlg, we show that students reacted very positively to the computational modelling activities, considering them to be important in the context of earth sciences courses and professional training. Students also considered Modellus easy enough to learn, user-friendly and helpful for meaningful learning processes of mathematical physics models. In addition, the digital PDF documents used to present the activities with interactive text, images, movies and free working space to insert multimedia enriched notes were considered interesting and well designed.
We also present evidence that the activities with Modellus and associated PDF documents were successful in identifying and resolving many student difficulties in aspects of physics, mathematics and scientific computation relevant for geophysics and meteorology courses. On one hand, the PDF documents proved to be very useful to explain the fundamental modelling ideas, problem solving processes and challenges to solve as well as to help students overcome faster the initial difficulties of using Modellus. On the other hand, with Modelllus students were able to create, explore and compare the proposed mathematical physics models and simulations. In this process, Modellus helped students establish meaningful relations between the mathematical physics models and the appropriate geophysical or meteorological phenomena as well as to operationally reify many mathematical objects students previously considered worthless. The activities also showed that models can be presented as differential equations solved by simple numerical methods and students can appreciate the differences between numerical solutions and analytical solutions. The computational modelling activities with Modellus were thus successful in introducing mathematical physics models and scientific computation methods relevant for the earth sciences, helping students be better prepared for a posterior more advanced application of professional software systems or programming

languages.

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Keywords: physics, mathematics and earth sciences education; computational modelling; interactive learning environments; university and secondary education

PS.05.02.W

Strand 6: Secondary School Physics

Parallel Session 05.02 Workshop
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D502 (4th Floor)

Nuclear physics in the Karlsruhe Physics Course (KPK) – a unified approach for the secondary school

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Compared to other physical domains nuclear physics seems to lack structure. It appears as a mingle-mangle of phenomena, radiations, reactions and detectors. Nuclear physics has failed to experience a process of structuring that every discipline needs in order to be teachable.
In the workshop, a new approach to nuclear physics is introduced. Many of the phenomena, that in traditional approaches appear as independent subjects, turn out to be only special cases of a single scheme. The method is scientifically rigorous and easy to use at the same time. The participants of the workshop will learn to decide which reactions can take place and which not, and how is the energy balance for any real or hypothetical reaction. They can answer questions like:
Which particles result from the decay of a neutron?
Can the proton decay into a neutron, an antielectron and a neutrino?
Which radioactive decay of any radioactive nuclide is possible?
Which fission reactions in the sun and other stars can take place?
What is the energy balance of a given reaction in a nuclear reactor?
Which light particles appear in the fusion of four hydrogen nuclei to helium in the Sun?
The trick is: Nuclear reaction equations can be established in a way that is copied from chemistry. Whereas in chemistry the number of atoms must be the same on both sides of a chemical equation, in nuclear reactions one has to keep track of three "charges": electric, baryonic and leptonic.
Students like the subject when taught in this way. The concept has been tested with several thousand students and was subject of final secondary-school examinations.
Participants will get a text in English language as well as tables of separation energies.

Keywords: Nuclear physics, Secondary school

Phy-scopes - physics through integrated computer-oriented problems and hands-on experiments

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Phy-scopes is an educational innovation project embedded in the general physics curriculum for bachelor students in engineering at Ghent University (Belgium). The objective is a substantial increase in the efficacy of the learning process, with a focus on mastering concepts and acquiring problem solving skills. This is pursued by partially replacing the plenary problem solving sessions by phy-scope sessions, a teaching format that aims to integrate solving computer-oriented problems with physical experiments.

During a phy-scope session the students work in groups of five on a single topic. The students are supposed to come prepared by reading the relevant chapter in their handbook and by completing an individual homework containing a number of single-concept problems. The first part of a phy-scope involves carrying out a related physics experiment. The experimental set-up is equipped with computer-controlled data acquisition for further analysis in a second part of the phy-scope. This analysis typically involves a number of computer-oriented problems that in turn can lead to additional experiments.

Within the project the first task was to identify a number of physics topics that lend themselves to the phy-scope approach. Apart from the content issue, there is obviously the availability or makeability of a sufficient number of set-ups as a practical boundary condition. For the first test phase the theme "resonance" was selected. The experimental set-ups consisted of either a mechanical oscillator (damped mass-spring system with tunable driving frequency) or the electrical equivalent (series RLC circuit). As both systems are described by identical differential equations, this particular phy-scope formed a mathematical link between the first year's and second year's physics course.

A first test was run with volunteering engineering students in their first bachelor year. Due to the participation on a voluntary basis, with the semester in full swing, the attendance was usually slightly biased towards the better-performing students. Nevertheless, from the students' feedback it could be concluded that treatment in the phy-scopes of content not covered in the lectures, e.g. RLC circuits, was perceived as (prohibitively) challenging.

A second test was programmed in the second bachelor year, with all students (about 250) participating. The focus of the phy-scope was shifted to RLC circuits, rather than mechanical oscillations. For the preparation the students still had to rely on self-study of the relevant chapter, as it was decided not to cover the topic in the lectures to avoid overlap. The homework consisted of a number of problems related to deriving the circuit equations and drawing phasor diagrams.

In a later stage the students worked in pairs, enabling individual guidance and differentiation between students with different backgrounds or study trajectories. A rather strict time limit was set for carrying out the experiments, ensuring an adequate preparation by the students. Further feedback from the students showed that they appreciate the hands-on experience gained with the physics experiments. Nevertheless, from a practical point of view, some students felt unsure about how the knowledge and skills acquired during the phy-scopes would be tested at the final examination. This is probably due to a lack of familiarity with this new teaching method, suggesting that the phy-scopes are best introduced already in the first year.

Keywords: physics, bachelor, experiment, exercise, computer

Looking at optics through the lens of inquiry

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Research in physics education has demonstrated that traditional physics instruction tends to have little effect on student ideas (Hammer, 2000; Thornton & Sokoloff, 1998; Van Heuvelen, 1991). On the other hand, research suggests that inquiry based instruction has a positive impact (Minner, Levy, & Century, 2010; Wilson, Taylor, Kowalalski, & Carlson, 2010). In spite of the evidence that shows the limitations of traditional instruction and the advantages of inquiry-based instruction, implementation of inquiry-based instruction in science classrooms has been limited (Barrow, 2006; DeBoer, 2004; Duschl, 2004; Minner, Levy, & Century, 2010).

This paper presents an action research study investigating the use of a laboratory experience based on the National Research Council (2000) inquiry standards. An existing geometric optics laboratory was transformed into an inquiry approach emphasizing the five essential features of inquiry NRC (2000). The five essential features include: "(1) learner engages in scientifically oriented questions, (2) learner gives priority to evidence in responding to questions, (3) learner formulates explanations from evidence, (4) learner connects explanations to scientific knowledge, and (5) learner communicates and justifies explanations" (p. 29). The study is being conducted by two experienced high school physics teachers in different schools. Working with students in Advanced Placement and International Baccalaureate physics classes, the teachers are comparing student learning experiences and outcomes while investigating thin lenses using a traditional "cookbook" lab to those that participate in the inquiry based lab.

The final paper will present the findings of the study. Pre and post assessments along with student artifacts will be examined in the light of five essential features of inquiry. We will discuss the students' experiences with both lab formats and compare learning outcomes. In addition, we will present teacher reflections related to the implementation of both types of laboratory activities. In our discussion, we will consider inquiry based instruction and its relation to the existing physics curricula of the Advanced Placement and International Baccalaureate programs. We will focus on the benefits and challenges of implementing inquiry methods into these well-established curricula. In addition, we will consider the effectiveness of a framework for transforming readily available teacher resources into effective inquiry tools. Finally, we will examine the conceptual change of the students and teachers regarding engaging, understanding and learning through inquiry.

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Keywords: Optics, Inquiry, Conceptual Change, Physics, Physics Laboratory

PS.05.03.c
Strand 4: Laboratory Activities in Physics Education
Parallel Session 05.03
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D504 (4th Floor)

A high school teaching/learning sequence on normal modes

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The physics education research group of the University of Milano has been working for many years to the construction of teaching/learning sequences in quantum physics. Within these paths a great importance is given to normal modes of oscillations and waves.
For this reason a didactic path on this topic has been implemented. We report here on two experimentations. The first has been proposed in the course "Waves" within the framework of "Milan Open Labs" of PLS (Scientific Degree Plan), that is an Italian national project in collaboration among M.I.U.R. (Ministry of Education, University and Research), Confindustria (Italian association of industrials) and Italian Universities, with the aim of promoting students' interest for scientific disciplines.
The PLS course has been attended simultaneously by about thirty high school students and twelve high school teachers and has been developed in eight afternoon sessions of about three hours each. Most of the lessons have been similarly structured: 1) an initial brain storming/discussion about a given topic, 2) a frontal lesson with demonstrations, 3) coffee break, 4) lab work in groups with guided inquiry suggestions and peer discussion, 5) general discussion of results, 6) last session with teachers only: discussion about the approach and the observation of students at work.
All the lessons have been video registered and many videos of the experiments have been also carefully made in order to highlight specific details, that are difficult to grasp by the naked eye, by using image magnification and slow motion.
The second experimentation, with a similar approach as the first one, has interested two high school classes and has been performed on a restricted number of topics during formal lessons at school.
Here we will briefly describe the teaching/learning sequence on normal modes, we will show some of the experiments that have been performed and we will discuss the results obtained in terms of the responses given by students to written tests and the lab activities and the observations and discussion with teachers.

Keywords: normal modes, lab activities, oscillations, waves, videos

PS.05.03.d

Strand 4: Laboratory Activities in Physics Education

Parallel Session 05.03

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D504 (4th Floor)

Preservice Physics Teachers' Representations Regarding the Whole Processes of Thermoacoustic Refrigeration

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Thermoacoustic is an interesting and synthetic subject to investigate how sound can be transferred to heat including variety of themes such as standing waves of sound, heat exchanges of adiabatic process and cycles of thermoengines. Making representations of the whole processes of thermoacoustic refrigeration could help students understand how diabetic cycle of sound wave stacks heat which is taken from colder region on hotter region. It has been reported that many students failed to build concepts of the above themes, because those are abstract and invisible procedures to understand intuitively. The purpose of this study is to investigate how preservice physics teachers represent and understand standing waves of sound, heat exchanges of adiabatic process and cycles of thermoengines using diagram, graphs and equations of the whole processes of thermoacoutic refrigeration. They asked to show how they represent their ideas before and after the thermoacoustic refrigeration experiments. Data analysis is based on mainly qualitative research method. Through the practices of making simple themoacoustic refrigerator, students could invoke their interest and familiarity about the issue and could elaborate their ideas and expressions in terms of standing waves of sound, heat and energy transfer during adiabatic cycle of sound wave. Even though preservice physics teachers completed introductory physics course which covers separately heat, energy transfer and sound wave, few of them were able to represent the whole processes within stack where thermoacoustic refrigeration occurred at first. However, they could develop their representations after the experiment. It could suggest that this experiment is a good example for preservice physics teacher to synthesize and explain the whole processes as well as each mechanism of standing waves of sound, heat exchanges of adiabatic process and cycles of thermoengines which seem to be distracted in various fields of physics.

Keywords: Representation, thermoacoustic, preserve physics teacher, standing wave, heat exchanges, adiabatic process, cycle of thermoengine, synthesis

PS.05.04.a
Strand 5: Primary School Physics
Parallel Session 05.04
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D505 (4th Floor)

Energy transformations in primary school: outcomes from a research based experimentation of an educational proposal

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University of Perugia and Physics Education Research Unit of the University of Udine, Italy

Energy is a topic which appears many times in Italian curricula. The socio-economical attention to protection of the environment and the sustainability of resources for development focused the attention to the energy topic in primary school: the text books were enriched, guided visits are organized to thermoelectric, hydroelectric, wind power systems and experts often are invited to make speeches on this topic in classroom. The approaches and contents of these contributions are those of newspapers and the common language. The foundation of scientific concepts in this field is thus further compromised. A vast literature has highlighted the fact that learning difficulties in this field are linked to common sense way of looking to energy concepts and its processing (Millar 2005, Heron 2008). Renewable (and not renewable) energy sources, energy saving, energy production and storage create a way of looking at energy in conflict with its nature of state conservative quantity that describes the processes in scalar way (Michelini 2008, 2011). Didactic proposals on energy topic of different approaches (Nuffield 1966; Kaper, Goedhart 2002; Hobson 2004) are today available and offer to the teacher the opportunity to treat this topic revisiting concepts in such a way as to help children overcome the conceptual knots (Driver, Warrington 1985; Heron et al. 2008, 2009; Van Heuvelen, Zou 2001) that the daily context poses.
In a research based experimentation the HMS (HMS - Heron 2008) approach is adopted to build the concepts of energy by means of experimental exploration, and to complete a teaching of energy based on the content offered by text book: energy form, energy production, living together in nature. In the same class children's thinking on energy was influenced by some analysis done by the teacher on the social problems related to energy producers, consumers and decomposition organisms, food chains, food networks.
The experimental class includes twenty three 8-year-old children of a school on the outskirts of Perugia, where wide is the presence of foreign children inserted from the beginning of schooling. All teachers deem the class a slowly progressing average performing one. Experimentation lasted 8 hours overall in a long period of time.
Activity has been performed using inquiry-based tutorials of HMS educational path, monitoring learning by means of interviews, boarding diary, in(I)-out(O)- and post(P)-tests (IOP tests). The same questionnaire constitutes the IOP tests and have been submitted respectively: I) after textbook based teaching and before HMS path activities, O) after HMS path, P) three months later, during which the class studied also other topics, not directly tied to energy, but nonetheless influencing students' thinking: human movement, human body, phase changes, heat propagation.
Here we present results of IOP test data analysis, especially concerning transformation concept, which appears not only in answers to the question about energy transformation, but also in other key concepts explored, such as: general view about energy, energy production, energy possession, energy loss.
Some interesting elements emerge, as for example in the I and P test children associate transformation to food chain and energy sources, while in O-test they describe changes observed in lab activities from one energy type to another. Even if our sample didn't use often the expression "energy transfer", main problems arise from the influence of traditional curriculum, which leads student to model energy transformation as an energy transfer between systems.
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Keywords: Energy concept, primary student learning, energy transformation, education research, educational proposal

PS.05.04.b

Strand 5: Primary School Physics

Parallel Session 05.04

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D505 (4th Floor)

Primary school physics, great challenge and great chance - developing of the new university seminar for future primary school teachers

Zdenek Drozd, Dana Mandikova

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Physics as a teaching subject starts usually in the sixth year of the school attendance in the Czech Republic. It means that pupils meet physics in the age of eleven or twelve. On the other hand, some basic physics phenomena are included in the primary school teaching subjects. It is mainly school subject "Natural Science" in which the basic knowledge about water, air, electricity, heat, magnetism, optics and others are introduced to little pupil. The above mentioned contradiction represents relevant problem with significant influence on the tuition in the primary schools. The authors of this contribution report how they deal with this problem. They developed a new seminar for future primary school teachers five years ago. The seminar is still in developing stage, but an important feedback was obtained during last five years. There is a very important aspect in the developing of this new university subject, which is reported in present contribution. By this aspect the authors mean the fact, that the seminar was created on request of students themselves. It was great challenge as well as great chance for them to do something for future primary school teachers and offer them a new opportunity how to learn something from physics. The seminar has been organized during last five years and the authors with their coworkers were obtaining many useful experiences within the tuition of the one. Such a feedback represents a new basis for present modifications of the seminar.

The seminar is introduced in this contribution. The context of the one is described and the authors focus their report on the content as well as on the methods used in it. The seminar consists of ten three-hours experimentally oriented sessions typically, and every of them are devoted to one of basic physics topic. These topics are discussed and some experiments are introduced within the contribution. Almost all aids which are used in the seminar are very simple. All of them can be easily prepared by children during the school lesson immediately. Examples of experiments are given and the experiments are discussed from various frames of reference. Discussion is done in the frame of didactics aspects of the preparation of future primary school teachers in physics and other disciplines which are not a standard part of their professional training.

The GIREP participants will be able to test some of these experiments and try to make some of the simple aids themselves.

Authors concluded that such a seminar brings new type of skills for future primary school teachers. They apply both, the skills and knowledge acquired there, in their school praxis after graduation from the university. The authors stay in contact with their former students to have appropriate feedback and use this information in improving the seminar.

Keywords: Primary school physics; Simple experiments; University seminar

OBJECT LITERACY: An important skill for primary school physics learning

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Object literacy is defined as the ability to "read" objects -- the ability to comprehend and communicate the information included in sets of objects. This unique aptitude is assumed to be necessary for effective use of instructional objects by science students in the elementary school. Persian and American children wee chosen as subjects differed: hence, level of object literacy for each group was anticipated to differ also. Further differentiation within the cross-cultural groups was encouraged by use of two different set of instructional objects, one more complex than the others. Selected learner aptitudes were also considered to be "general" and "differential" predictors of object literacy variables. One hundred and thirty-seven 10-12 year old boys (78 American; 59 Persians) were individually tested on the amount and type of information they recalled from sets of Simple or Complex objects. Complexity of objects was defined in terms of variations in object attributes. The four treatment conditions (two in each culture) and both performance and objective measures of object literacy are described. Object related experiences (long range and short range) were controlled in the experimental procedures.
Real differences in object literacy exist between populations whose previous experience with objects differed. Persian showed superior recall of specifics (Level I object literacy) but Americans clearly demonstrated a higher ability to cluster information (Level II object literacy). The latter is a better estimate of functional object literacy since categorization is a prerequisite for other more complicated processes such as concept learning and problem solving. The more extensive past experience with objects, therefore, had a positive influence on Level II object literacy.
Since learning physics concepts in primary school is based on experiment, having object literacy can become essential for this type of learning.
Keywords: Object literacy, preschool, physics learning

Keywords: object literacy, physics learning, primary school, cross-cultural research

PS.05.04.d

Strand 5: Primary School Physics

Parallel Session 05.04

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D505 (4th Floor)

Can Einsteinian concepts be taught in primary schools?

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We report a pilot study and the use of drama in science education, by the Science Education Enrichment Project, an Australian Research Council funded project in Western Australia, which is exploring and measuring the effectiveness of science education enrichment. The project is a partnership between The Gravity Discovery Centre (GDC) and The Graham (Polly) Farmer Foundation (GPFF), the University of WA and Curtin University. The GDC is dedicated to using frontier science to promote science education while the GPFF is dedicated to enhancing indigenous education outcomes.
Albert Einstein was instrumental in the creation of the two theories of physics that underpin our understanding of the universe - the theory of gravity called General Relativity and the theory of particle interactions called Quantum Mechanics. Normally these topics are taught at university physics departments. Our pilot study tests the idea that the concepts of Einsteinian physics can be taught in primary school.
Einsteinian physics is the culmination of centuries of debate. Most people still hold to the old idea that space, time and matter are independent and separable entities. We have been indoctrinated with 2300-year-old Euclidean geometry. While it is proven that space, time and matter are all interconnected, we still force our children to learn the naïve simplification called classical or Newtonian physics.
We set out to investigate whether 11 to 12 year old students in a normal state school could assimilate Einsteinian ideas. During instruction, the students drew triangles on balloons, and traced the paths of parallel lines. They explored the history of ideas about space from Pythagoras to Newton to Einstein. They discussed the meaning of a straight line and learnt that the path of a light beam is the only arbiter we have for straightness. They learnt about observations of the curvature of space.
Using simple space-time graphs and Einstein’s assertion that freely falling trajectories are always the shortest paths in space-time, the children discovered Einstein's key prediction that time depends on your height above the ground. They learnt that GPS navigators only work because the satellites are corrected for the time warp around the Earth. Our astonishing discovery was that the students were not very surprised. Unlike many adult audiences, they showed no sign of bewilderment. Most of the students did not think that they were too young to learn Einsteinian ideas. They learnt to think about space-time. They learnt to appreciate that falling from a tower and floating in the space station are really the same thing. They easily grasped the reality that parallel lines can cross and that the perimeter of a circle is not exactly Pi times diameter. Most importantly, they thought that it was really interesting.
To reinforce the concepts they had learnt, the students performed a light-hearted play called Free Float in which scientists from Pythagoras to Newton, Kepler to Einstein, and modern scientists who proved Einstein’s theory of gravity all come together with a group of students to discuss, question and criticise each other. The play also provided a public demonstration of how we could bring primary science into the 21st century. We will present the outcomes of the pilot study including analysis of test results, questionnaires and interviews.
We will argue against the common attitude that we do not need to worry about Einsteinian physics - Newtonian physics is good enough! We will argue that we owe it to our children to teach our best understanding of reality instead of the 300-year-old Newtonian approximation founded on the false idea that space is fixed, absolute and independent of matter.
Based on our evidence, we will argue that young brains can assimilate modern ideas of curved space much better than old brains that have been indoctrinated with Euclid’s flat space. Catch them young and they will be much better able to integrate Einsteinian physics with those very useful approximations that are Euclidean geometry and Newtonian physics.
We will argue that there are even more important reasons to teach modern physics to young people. Modern physics includes weirdness and mysteries that we do not fully understand. The concepts still challenge the professionals; there are open questions and our understanding is clearly not complete. Physics is an adventure that is still going on. How much more exciting to learn about an adventure, to be part of an adventure, than to learn old stuff!

Keywords: Teaching Einsteinian concepts, primary school, drama in science education

PS.05.05.a

Strand 7: University Physics

Parallel Session 05.05

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D506 (4th Floor)

A case study of the role of representations in enabling and constraining the sharing of physics knowledge in peer discussions

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Representations are the semiotic building blocks of all meaning making (Lemke, 1990). In a scientific discipline such as physics these representations include spoken language, written language, gestures, pictures, sketches, diagrams, graphs, computer simulations, mathematical formulations (such as equations) and so on.

Research has shown that learning is enhanced through discussions where students are given the opportunity to build and share physics knowledge amongst themselves and/or with their teachers, (see Hake, 1998; Mazur, 2009; Van Heuvelen & Etkina, 2006). An important aspect of doing physics is embedded in the representations that are used (Kohl, Rosengrant, & Finkelstein, 2007; Podolefsky, 2008; Rosengrant, Etkina, & Van Heuvelen, 2007). For example, a growing body of research is increasingly suggesting that how the disciplinary representations are used plays a critical role in problem solving in physics (see the extensive review by Rosengrant et al., 2007). Despite the widely recognised value of peer discussions in learning contexts, little research has been done at the university level into the role that disciplinary representations play in enabling and constraining the sharing of knowledge in physics in such discussions.

Since it is highly unlikely that any single representation can fully afford access to understanding of a given phenomenon (Kress, 2010) physics discussions will need to draw on a range of representations in the process of building and sharing knowledge. Using case study examples, Airey and Linder (2009) have theorised that there will be ‘critical constellations’ of representations that students need to be ‘fluent in’ in order for them to reach holistic and appropriate meanings. This proposition led us to the Research Question: From an educational point of view, what potential for building and sharing physics knowledge do different physics representations of a given phenomenon have?

To start exploring these questions we performed a case study at a Swedish university with a group of three highly regarded senior undergraduate physics students who were asked to explain why refraction of light takes place. Our analysis draws on Lemke’s (1983, 1988; 1990; 1995) notion of thematic patterns (‘patterns of semantic relationships’) which was originally grounded in Halliday's (1978; 2004) Systemic Functional Linguistic approach to analyzing language. Our results illustrate how a particular representation can be decisive for the successful constitution of an appropriate physics explanation. The analysis we will present begins with the participating students struggling to explain the refraction of light using a ray diagram representation. The analysis goes on to illustrate how the students recognise the limitations of the ray diagram for providing a ‘why’ explanation. Our presentation will describe the way in which the students’ noticing of the limitations of their original diagram led them to shift to using a wave front diagram. Finally, we will illustrate how we drew on Lemke’s model of ‘thematic patterns’ to provide a way to identify how the participating students used the wave front representation of light to facilitate the bringing together of a number of educationally critical aspects for an appropriate explanation of the refraction of light.

We interpret our analysis as illustrating how different representations that may be seen as equivalent from an underlying physics point of view, often actually have quite different ‘disciplinary affordances’(Fredlund, Airey, & Linder, in review).

We will conclude that it is important for students to come to appreciate the enabling and constraining qualities that any particular disciplinary representation may have for the building and sharing of physics knowledge. We suggest how teachers may be able to use such knowledge about representations as a heuristic when interacting with students individually or in groups.

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Keywords: Representations, peer discussion, thematic patterns, affordances, refraction

PS.05.05.b

Strand 7: University Physics

Parallel Session 05.05

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D506 (4th Floor)

A cross sectional study of university students multiple representational ability

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It is suggested that disciplinary expertise comes with an increasing literacy of using the disciplinary discourse (Airey & Linder, 2009), a suggestion supported by enculturation into communities of practice. The discourse includes representational practices, from pictorial and symbolic representations of cave paintings and Egyptian hieroglyphics, to alternative portrayals of language such as sign language or Braille, to abstract representations including mathematical equations or graphs. The purpose of alternative representations from the spoken or written word is often to communicate more effectively or efficiently in a specific context, whether it is in presenting financial reports, advertising campaigns or scientific research.These contexts can be known as “communities of discourse” in which groups use common language and representations to communicate (Driver, 1994).

One facet of the physics disciplinary discourse is the different representations that are reproduced as written material including diagrams, graphs, equations and words. It would appear that being fluent in these representations is a necessary skill for success in physics. While multiple representations is an area of study, cross sectional studies of students multiple representational ability are lacking. This aim of this study was to examine trends in students representational ability using a cross sectional study. The explicit question we address is: Do students in different years of study in university physics have different multiple representational ability. This investigation involved the creation of a 7 problem instrument designed to test a student’s representational ability. The test was validated, coded checked for consistency. It was administered to 625 university students studying undergraduate physics at the University of Sydney. By tracking the changes in representational ability across various levels of physics learning experience, it was found that there was a significant difference between the representational ability of the 1st year fundamental and regular students (students with low representational ability) and the 1st year advanced, 2nd year and 3rd year students (students with high representational ability). This result is supported by investigations on how well students answered representational questions, the representations they used in their responses and the number of representations that they used. There is no mention of such a trend in extant literature, largely because there have been no studies that track representational ability across closely spaced levels of physics learning.

Airey, J., & Linder, C. (2009). A disciplinary discourse perspective on university science learning: Achieving fluency in a critical constellation of modes. Journal of Research in Science Teaching, 46 (1), 27-49. doi: 10.1002/tea.20265

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Keywords: multiple representations, novice to expert, graphs,

PS.05.05.c

Strand 7: University Physics

Parallel Session 05.05

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D506 (4th Floor)

Who needs 3D when the Universe is flat?

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Learning astronomy can be difficult for students at all levels due to the highly diverse, conceptual and theoretical thinking used in the discipline. A variety of disciplinary-specific representations are normally employed to help students learn about the Universe. Some of the most common representations are two-dimensional (2D) such as diagrams, plots, or images. In astronomy education there is an implicit assumption that students will be able to con- ceptually extrapolate three-dimensional (3D) representations from these 2D images (e.g., of nebulae); however, this is often not the case (Hansen et al. 2004a,b; Molina et al. 2004; Williamson and Abraham 1995; N.R.C. 2006, p. 56).

The way in which students interact with different disciplinary represen- tations determines how much and what they will learn; yet, our literature review indicates that not much is known about this interaction. We have therefore chosen to investigate students' reflective awareness evoked by 3D representations. Reflective awareness relates to the learning affordances that engagement with a collection of representations facilitates. The notion of reflection is drawn from the work of Schön (cf. 1983) in that it is related to our learning experience and involves the noticing of 'new things' and the noticing of 'things' in new ways as part of dealing with puzzling phenomena. Much of the research into Astronomy Education Research (AER) has been carried out at pre-university levels (Bailey and Slater 2003; Bailey 2011; Bre- tones and Neto 2011; Lelliott and Rollnick 2010), and furthermore very little has been grounded in a disciplinary discourse perspective (Airey and Linder 2009). Our study sets out to address both of these shortcomings.

Our research question is: What is the nature of university students' re- flective awareness when engaging with the representations used to illustrate the structural components and characteristics of the Milky Way Galaxy in a simulation video?

Although not common, when 3D is introduced, then this is often done using video simulations. For our study we chose to use a highly regarded video simulation that illustrates some of the fundamental structural components of our Universe in a virtual reality journey through, and out of, our galaxy. In the study, the first 1.5-minutes of the video was set to automatically pause in seven places (these places where optimally determined in a small pre-study), and a web questionnaire was created to elicit the participants' reflective awareness about the structural components and characteristics of the Milky Way in each clip. A total of 137 participants from physics and astronomy in Europe, North America, South Africa and Australia took part in the study. The written reflective descriptions from the survey were coded and sorted into constructed categories, using a constant comparison approach (cf. Gibbs 2002; Strauss 1998).

Many of the participants expressed poor prior awareness of the 3D struc- ture of the universe, as evidenced by their 'surprise' in observing 3D features such as the large separation of the stars in Orion or the two nebulae in Orion. Many were also surprised by the extent of the grand scale of the (local) Uni- verse as they realised that the journey covers great distances in only a few seconds. In contrast, those participants who rated themselves as astronomy experts had already developed a 3D awareness of the universe. They used much more complex descriptions and to some extent commented on struc- tures and phenomena omitted from the simulation, such as HI-regions and infrared radiation from HII-regions, although these are invisible to the naked eye.

In this talk we report on 3D-related issues, which we will discuss in re- lation to implications for using such a simulation as a resource intended to enhance the possibility of learning. There are two main findings of our study concerning 3D: firstly, one of the clearest differences in reflective awareness to emerge was that there was a gradual increase of awareness of structures and phenomena in relation to the educational level of the astronomy partic- ipants. Interestingly, this is not the case for the physics participants and we will argue that this is due to differences in the disciplinary discourses of physics and astronomy. The second finding is that the use of the simulation video successfully stimulated participants' awareness of the 3D structure of the Universe as seen in their expressed surprise. We therefore argue that simula- tions can be a powerful and necessary tool in helping develop an awareness of the three-dimensional Universe and that simulations therefore are one of the critical forms of representation that open up the space for learning in astronomy.

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Keywords: University Physics, University Astronomy, Disciplinary discourse, 3D representations

PS.05.05.d

Strand 7: University Physics

Parallel Session 05.05

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D506 (4th Floor)

How well do first year university students learn to use multiple representations of physics concepts for understanding and problem solving?

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Students who complete physics courses need to have demonstrated the achievement of a number of prescribed course learning outcomes such as knowledge of fundamental physics concepts and principles and application of those physics principles to understand the causes of problems, devise strategies to solve them, and test the possible solutions.

What is not usually explicitly taught, though implicitly expected of students enrolled in physics, is the ability to use multiple representations (e.g. descriptions using words, diagrams, equations or formulae, and graphs) of fundamental physics concepts and to be able to understand and link different representations and hence develop a deeper understanding of the physics concepts. To teach effectively using multiple representations, it is necessary to explicitly present students with different forms of these representations.

This presentation will describe a case study involving 150 first year university students in a physics course for non-majors. Two questionnaires on Thermal Physics and Optics were developed to assess students' conceptual understanding and their use of multiple representations to explain the concepts. We also conducted interviews to link students' explanations to their responses in the questionnaire items. Two research questions guided the study: 1) How and to what extent do students use different representations to learn and communicate their understanding of physics concepts? and 2) How do different representations help students build deeper understanding of physics concepts? The results showed that even with explicit teaching, learning physics using multiple representations is difficult for these non-physics majors, and a large number of the students were unable to apply all four representations effectively to solve physics problems. Nevertheless with increased guided instruction, students were able to demonstrate more multiple representations and their connectedness.

For physics instructors who want to assist students' improvement of their conceptual understanding, this study has shown that it is necessary to systematically and explicitly introduce the different representations in lectures, tutorials and assessment.

Keywords: multiple representations, thermal physics, optics, concepts, problem solving

PS.05.06.a

Strand 12: History of Physics

Parallel Session 05.06

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D404 (3rd Floor)

Discovering the Law of Refraction: a Guided-Inquiry Approach with a Counterpart in the History of Physics

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The law of refraction of light involves the ratio of sine functions – does this preclude it for students who don't know trigonometry? And does it make it too difficult for students to 'discover' for themselves in an inquiry-based course? After all, the task took scientists hundreds of years. Seeking to design an accessible guided-inquiry approach to the law, we 'invented' a geometrical representation: A reference circle is centered where a ray refracts and incident and refracted ray directions are specified by not by angles but by semi-chord lengths in the reference circle, i.e. by 'offset' distances from the normal line, as illustrated in the diagram. Besides being interesting in its own right the representation facilitates an inquiry-based discovery of the law, whether or not students know trigonometry. The scientific-inquiry learning sequence is as follows. Students explore the phenomenon, then trace ray directions for light encountering the interface between media, over the full range of possible directions. They then seek a possible relationship between the incident and refracted ray directions. Most initial attempts are unsuccessful; in particular, taking the ratio of the angles of incident and refracted rays, initially very promising, fails to work at the larger angles. Students then turn to semi-chords, and eventually succeed in their quest, discovering a relationship that works at all angles. Students then formulate for themselves a simple elegant law for refraction, along these lines: "The incident and refracted ray directions are such that the ratio of semi-chord lengths in a reference circle is always constant".

The approach proves successful in a number of ways: students indeed discover the law; they learn about scientific inquiry; they are engaged by the challenge; and ultimately feel proud to have solved the case via 'scientific detective work'.

Initially, no history of science was involved in our developing our instruction. But we were then intrigued to learn that we had been beaten to this representation and form of the law by nearly 400 years! By Descartes among others. Thus in our case, inquiry pedagogy and the geometric representation have direct counterparts in the history of physics.

Note that historically many scientists attempted to find a law for refraction; Kepler for one came very close but did not succeed. He was seeking an empirical geometrical relationship rather than a physical mechanism to explain the phenomenon, while on the other hand Newton and Descartes proposed explanatory models involving forces on light particles to account for the fact that light changes direction at an interface. Note that although Snell's name is usually associated with the refraction law, he was not the first; Ibn Sahl and Harriot have been belatedly recognized for their work.

The circle and semi-chord representation, besides its usefulness in discovering the law, also serves well for problem-solving thereafter. Refraction problems can be solved by accurate ray construction using semi-chords. Such ray tracing procedures simulate light behavior and in this sense are arguably superior conceptually to substituting angles into trig formulas. As a side benefit, the representation also brings out the underlying meaning and power of trig functions – if students go on to the sine formulation they can see a reason why trigonometry was invented!

Note that the geometrical approach, while conceptually advantageous and ideal for inquiry, is virtually ignored today; most textbooks simply present the law in abstract sine function form as an established fact. A notable exception was PSSC physics in the 1960s, with a wonderful treatment of refraction, but apparently with little lasting effect. However, given the strong advocacy of inquiry in recent science education standards, the approach may finally find its rightful place.

In our presentation we discuss the geometrical representation and inquiry-based sequence, and relate these to aspects of history. We show examples of student investigations leading to law formulations, and examples of student problem-solving with semi-chords. Student reaction has been positive; they are intrigued by the he discovery narrative and challenge. Performance-wise, students learned to solve basic refraction problems without formal trigonometry, and even to transfer their knowledge to image problems.

Finally, we contrast our approach with prevalent textbook treatments, which present Snell's law directly upfront and then use it in numerical problems. This is virtually the opposite of our guided-discovery approach, and reflects a very different epistemological stance toward both science and learning science.

Refraction approached this way has proved to be one of our best exemplars of effective inquiry-based science learning. We frame our work in terms of four science & instruction issues, viz. inquiry-based learning, nature of science, representations, and the history of science, and show how these can work together to enhance the student learning experience. Note also that the history of science is used not to introduce a science topic or simply to add interest, but post hoc, to affirm students' own discoveries.

Keywords: Law of refraction, guided inquiry, inquiry-based instruction, representation, history of science

PS.05.06.b

Strand 12: History of Physics

Parallel Session 05.06

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D404 (3rd Floor)

Models' construction of historical scientific instruments as part of Physics' teaching in Greece: Measuring and Interpreting Nature within History

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The educational aspects arisen from the history of the scientific instruments can be very helpful for students'study in order to understand science itself. Moreover, the study of the scientific instruments can be distinguishly helpful for students who study exact sciences to achieve an efficient understanding on the work of distinguised scientists who have invented and experiment those instruments.

More specifically, we propose that we can bring on the issue of reconstructing certain scientific instruments and use them as demonstration in classrooms (or virtual groups of students in distance education institutes) adjusting this method to the educational level of the secondary education in Greece. We also can adjust this procedure with innovative approaches of learning such as e-learning and use some of the pedagogical tools of e-learning.

Under this scheme we move towards a student-centered orientation in science groups because students' work should be into consideration for the outcomes. Groups of students located at different places can create some of the instruments themselves and trace the main experimental steps taken by the inventors/creators of the specific scientific instruments in order to measure magnitudes or to interpret natural phenomena.

We use as case study Tycho Brahe's lifelong work on creating astronomical instruments. Focusing on his efforts to achieve more accurate results in order to interpret natural phenomena in heavens, students get in the position to observe from a different point of view the multifold layer of the evolution of scientific thought in astronomy. Tycho's work on creating instruments can be considered as an innovative pedagogical approach for astronomical phenomena during the last decades of the 16th century. His assistants could confirm or reject modern aspects of astronomy at that time and, moreover to learn innovative techniques about instruments' construction. This case shows the importance of the study of scientific instruments as part of a comprehensive study of Physics.

The proposed methodological approach has been enquired and modern bibliography has been enriched by several works (i.e. Seroglou & Koumaras P., 2001, 'The Contribution of the history of Physics Education: A review', Science and Education, 10, pp.153 - 72. and Nielssen H. & Thomsen P.V., 1990, 'History and Philosophy of Science in Physics Education', International Journal of Science Education, 12(3), pp.308 – 16 etc).

The implementation of this project in the Greek educational system can be enquired thoroughly within the network of the Pilot Junior High schools in Greece and then we can evaluate it so that we can reach more comprehensive conclusions.

Keywords: Physics, teaching, History of Physics, historical instruments, Greece, educational system.

PS.05.06.c

Strand 13: Philosophy, Nature, and Epistemology of Science

Parallel Session 05.06
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D404 (3rd Floor)

The Development of Undergraduate Students' Perceptions of Physics and Physicists

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Students' perceptions of Physics influence their approach to study and learning outcomes. However, the process by which students become Physicists and move from a naïve view to an understanding of what it means be a Physicist has not been investigated in depth.

This study is an initial attempt to explore some of the issues underlying this process by ascertaining how Physics students' beliefs about what it means to be a Physicist change as their studies progress, and how these attitudes affect their approach to learning tasks.

A pilot study was undertaken in the second half of 2011, with students in core Physics courses at the University of Queensland invited to complete a survey to measure their attitudes to Physics. A small number of informal group interviews were also conducted.

The surveys were based on a small subset of the CLASS (Colorado Learning Attitudes about Science Survey) questions, and showed that, in general, all levels of undergraduate students at The University of Queensland have attitudes consistent with experts, with no significant change between years of study. The only notable changes were that later year students were more consistent in believing that they could solve Physics problems if they understood the related concepts, and they were also more likely to discuss Physics with peers. The advanced students are also slightly more polarised in their approach to problem solving (some believe strongly in 'formula fitting', while others are strongly opposed).

Data from the interviews show that students do change their perspective on what Physicists do as they progress through their degree. Students early in the program appear to believe that Physicist only perform research, whereas more advances students also consider work in teaching and industry.

A refined qualitative mixed-methods approach will be used over the whole of 2012 to analyse these changes in student attitudes in greater detail. Survey data will be used to give a quantitative view of the development over each semester of the degree. This will be combined with focus group interviews from a selection of students and observations of behaviour in class settings. Interviews will focus on what students usually do when they approach their work on Physics courses, and how this correlates with what they believe a Physicist would do in the same situation. Classroom observations will be included to ascertain how any variation in student beliefs manifests in their learning behaviour.

A preliminary analysis of data from the first half of 2012 will be presented at the conference.

It is hoped that this project will contribute to an understanding of how students 'become' a Physicist. This would help provide direction to, and a framework for evaluating, curriculum developments.

Keywords: Tertiary, Student Attitudes, Ontology

PS.05.06.d

Strand 12: History of Physics

Parallel Session 05.06
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D404 (3rd Floor)

Geometric historical approach to investigate celestial bodies with a full Digital Planetarium

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In 2009 a fully Digital Planetarium (DP) has been built in Caserta (a city near Naples, http://www.planetariodicaserta.it), with the support of the City Municipality and EU funds Urban2.
DP proposes activities for students, teachers education, general public.
Main objectives are:
° to improve the basic scientific knowledge of students (from Primary to University) through experiences by means of digital representation of celestial phenomena;
° to link with salient achievements in History of Physics and Astronomy;
° to help in-service teachers develop deeper competences on the addressed topics;
° to offer citizens high-quality scientific edutainment.
At secondary school level, in 2009 - 2011, about 200 schools, 300 teachers and 7000 students have been involved; teachers and students education is combined according to active-learning strategy.
Typically a DP activity is prepared in class by lecture, books and web to build a basic background for the topic to be addressed. The DP focuses on showing and discussing details in a multimedial advanced ambient (the dome) from different points of view (Earth vs Space, for example).
Students and teachers live an intense cognitive experience due to the innovative technology used as well as the methodological approach to build models.
Since Eratosthenes (230 B.C.), through Aristarchos, up to Galilei (1610) and Halley (1716), use of geometrical Euclidean methods allowed Astronomy to estimate several dimensions and distances in Solar System (Earth radius, angular dimension of Sun and Moon, Moon diameter, Moon and Sun distances to the Earth, size of Moon’s mountains and distance of closer stars).
For each of the quoted historical experiences, the activities of the DP lead students into the historical contexts, offer a panoramic on the astronomical properties of the bodies involved, represent the celestial phenomenon on the dome, perform the original measurements and compare them with the mathematical model. All activities are done in real-time with the help of a professional scientific tutor.
The didactic path is later continued in class by discussing the observations, the physical and mathematical features, the critical aspects of historical methods, their success or failure and the approximations involved.
The DP activities have been positively evaluated by students and teachers; their success is increasing.

Keywords: Physics and Astronomy, full digital planetarium, geometrical hystorical approach, students/teachers education

PS.05.07.a

Strand 14: Socio-cultural Issues

Parallel Session 05.07
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D405 (3rd Floor)

Use of graphics and tables in argumentation written task about a sources of energy dilemma in secondary school

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Argumentation has recently become a common topic of research in science education with a number of studies about student argumentation in science classes increasing significantly in the last years (Erduran & Jiménez-Aleixandre, 2007). On the other hand, the interpretation and construction of graphs is a classic topic still present in science education research (Janvier, 1987; Wu & Krajcik, 2006). In contrast, research on learning to construct and interpret tables is very scarce (Martí, 2008). Still less common is to find research that deals with the use of tables and graphs as evidence to justify a given argument. The present work analyzes middle high school students' use of Tables vs. Graphs justifying their claim in an argumentation written task about an energy dilemma.

Methodology

A dilemma about two power stations of different sources of energy, a fossil-fuel and a nuclear one, was presented to fifty 13-to-14-year old students. Different arguments were included supporting each claim. The task performed by the students, individually, had two parts. In the first part they had to decide about which one they prefer, justifying it in a written text. In the second part, the data (graphics or tables) were given to students. Half of them had tables and the other half graphics. We asked them to write a second text confirming or changing their previous position with the support of the data. We have analyzed both written parts: the first one, in order to identify students' arguments, the second one, to compare the arguments found in this part with the ones of the first part for each student. We are able to identify how they used tables or graphics building their new arguments. The categories used for this analysis are: 1) keeping or changing their position, related to the first task; 2) giving the same arguments or adding new arguments in the second text in comparison with the first text, 3) using the tables or graphs to defend their positions and/or to disconfirm the alternative position, 4) different strategies used to construct the arguments integrating the tables or graphs into their arguments.

Results-Discussion

We found interesting that the majority of students maintain the same claim, using the tables and graphs as a support. There is no significant difference between using tables or graphs and changing their claim in the second part of the activity. Students can be categorized into several groups according their general strategies using graphs or tables in their arguments that go from a simple reading o commenting the data to the integration of this data into the arguments. Students can also be categorized in relation to the specific strategy coming from the way they interpret tables or graphs to its integration in the arguments (literal reference to graphs or tables, reference to local data, reference to global trend, etc.). These strategies are related to the condition of having tables or graphs in the second part of the task. The interpretation of graphs as tendencies favours their integration into the arguments.

Implications for science education

The results of our study show us that the strategies used from students for their interpretation of tables or graphics are quite different. This difference influenced the way the students construct their arguments. The integration of tables in their arguments is not easy for them because their interpretation is also more difficult and complex. An implication of our study could be that teaching tables in school should be more explicit and detailed than communly is done. We should pay more attention to the instruction of tables in school.

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Keywords: Argumentation, High middle school, Energy, Dilemma

PS.05.07.b

Strand 14: Socio-cultural Issues

Parallel Session 05.07

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D405 (3rd Floor)

Comparison of Turkish and American Students' Attributions of Success/ Failure in Modern Physics

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We all seek "causes" to make sense of our experiences to try to identify unknowns influencing events. In educational settings, students' understanding of what leads to academic success has a strong influence on what they attend to and what they do in a classroom. Whether or not they have correctly identified a true cause or not, it is their "perception or inference of cause" that influences their behavior. This is referred to as "attribution" and there is a significant literature studying student attributions (Försterling, 2001; Kelley & Michela, 1980, Weiner, 1974, 1979). Previous research demonstrates a relationship between students' attributions for success/failure and their achievement, and that improving students' attributions can improve their performance (Bar-Tal, 1978). Cultural/social context is one factor that has been shown to affect student attributions. In this study, we examine the variation in attribution patterns for success and failure in a modern physics class in two different cultural settings. We studied students at two universities, one in the USA and one in Turkey respectively. We conducted structured interviews with twenty-seven (fifteen from USA and twelve from Turkey) participants and examined how they perceived their success and failures in modern physics. The interviews started with participants' descriptions of their perceptions of "success" in modern physics and the causes of their success and failure in the class. Finally, we presented a list of 25 attributions developed from the literature and our previous fieldwork to participants, and asked them to discuss each one and rate them on a 1-5 point scale. "Abstract thinking ability and interest to modern physics course" were identified as the strongest attributions for both Turkish and American students. However, Turkish and American students' other attributions varied significantly. We analyze these in terms of stability and locus of control, and identify common and discriminating patterns of success.

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Keywords: Physics education, attribution, modern physics.

PS.05.07.c

Strand 14: Socio-cultural Issues

Parallel Session 05.07

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D405 (3rd Floor)

A model of conceptual distribution for physics education

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Since the 1970s, research in physics education was concerned with students' prior ideas about physical phenomena. Many studies have shown that these conceptions are deeply rooted and often resistant to change. Since then, many efforts have focused on changing students' misconceptions. The best known theory of conceptual change was developed by Posner et al. (1982). By taking philosophy of science as their major source of hypothesis, they outlined a particular model to explain "the process by which people's central, organizing concepts change from one set of concepts to another set, incompatible with the first" (p. 211). This model guided research in physics education for many years. In the 1990s, however, the theory of conceptual change was seriously challenged. One particular problem was the assumption that student should abandon their prior conceptions in favor of new, scientific ones. According to many researchers, the goal of instruction should be to improve students' ability to coordinate alternative points of view and use them in appropriate contexts. This and other criticisms have led to the reframed approach to conceptual change (Vosniadou 2007). More recently, conceptual change and other related notions have emerged in sociocultural studies. Many researchers are now interested in reconsidering the problem of conceptual change from a sociocultural perspective (Tobin 2008). Drawing on writings of James Wertsch (1998), we formulated a distributed version of conceptual change. According to this model, conceptions are distributed between active agents and the textual resources they employ, especially textual resources in the form of explanations. From this perspective, conceptions are viewed as being distributed: (1) socially, in small group interaction, and; (2) instrumentally in the sense that it involves both people and instruments of knowledge. By considering explanations as cultural tools, learning physics invariably takes the form of mastering scientific explanations provided by others. This claim has seriously implications for physics education. First, the explanations students provide are not the product of independent research. Instead, they constitute items from a "tool kit" that exists in their sociocultural settings. Second, the mastery of a new explanation does not imply the disappearance of daily forms of talk. It calls on us to understand why some forms of explanation, as opposed to others, are "privileged" in particular contexts. Finally, by taking explanations as cultural tools, the focus of analysis changes from cognitive to social phenomena. As different settings presuppose different tools, one may view physics education in terms of border crossing into the subculture of a different group (Aikenhead 1996).

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Keywords: Physics education, conceptual change, sociocultural perspective, conceptual distribution

PS.05.07.d

Strand 14: Socio-cultural Issues

Parallel Session 05.07

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D405 (3rd Floor)

The Popularization of National Science as an Important Factor of Students Engagement

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The social changes characteristic of recent decades has deeply affected the school environment. The value of knowledge has change, and students are not interested in science lessons. How these changes affect the development of teaching activities in the classroom is one of the question researchers are looking to answer. The basic issue is how teachers and students construct their identity outside school and how it affects their role in the classroom. Initial results have shown that certain social groups create a cultural mismatch that leads to an exclusion process with respect to learning in science.

According to Stuart Hall, nationality is a central aspect of our identity. Thus, people from some countries are not aware about science made localy. Even if a country has goods scientists, it is not warranty that their work is sprayed in local media. Students think there aren't a reason to learn science if their country is not a science producer.

We support that in this case a kind of "invisible obstacle" is formed between the possibilities of interaction with teachers and students, troubling the learning process. This paper aims, at first, use the notion of identity studies, based in education and in social psychology and sociology areas, willing to explain how identity processes are formed and how these affect the ratio of students with learning science. We analyze a sequence of activities that complement the teaching of some topics in Modern and Contemporary Physics seeking to illustrate how scientific topics could be worked while considering the issue of cultural differences as an obstacle.

In our intervention, we found that students do not perceive science as something representative of the Brazilian cultural production. Only countries as USA, Japan and European ones have been recognized as science producer. Even if a Brazilian student knows a scientist, he doesn't know what is his work or how his work is important.

Seeking to understanding and change this situation, a teach-learning sequence was created with the introduction of a brazilian scientist's viewpoint: Cesar Lattes. With this strategy, we found that the students begin to perceive that science can be an important part of the brazilian culture. However, the students also question the social dimensions involved in the possibilities of scientific development in Brazil. To deal with this issue, the students have visited a particle accelerator at the University of São Paulo. We observed a strong indication that the proposed activities created a link between the Physics content studied with the national scientific production. The big change that ensued was to no longer consider science as an activity that is only conducted abroad, a group that is culturally very distant from the Brazilian students, but to help students perceive that science is part of their own culture.

Our research indicates that is important the popularization of local science. This is an important factor o engagement of students in science lessons.

Keywords: culture physics national context

PS.05.07.e

Strand 16: International Perspectives

Parallel Session 03.06
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D406 (3rd Floor

Physics Education in Decline: an international perspective and the Irish context

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General description on research questions, objectives and theoretical framework:
Some science fields and physics in particular are in decline in many developed countries. According to the Organisation for Economic Co-operation and Development [OECD] (2008), there are predictions of shortages in most engineering disciplines (United Nations Educational, Scientific, and Cultural Organization, 2010) and many OECD countries report serious under enrolments in university physics and mathematics courses. The European Round Table of Industrialists has recently concluded that "it is clear that Europe is facing very negative trends in the supply of human resources in MST (Maths, Science and Technology)" (ERT, 2009:9). Newspapers are awash with stories of cloning, genetic modification and medical breakthroughs. It is appealing to be a biologist, and the justification for a biology career is clear. Physics in contrast is unpopular, even though it provides the basis for much of science. It is regarded as a vital discipline which underpins many other academic disciplines and many aspects of industry (Research Councils UK, 2008). However, the take-up of Physics in the UK, as well as USA, Germany and Australia at both second and third level is less than encouraging. This article will present Physics enrolment figures for the above-mentioned countries at second and third level; this will be followed by an analysis of the main factors responsible for the decline in the take-up of physics at second level in Ireland in recent years,

METHODOLOGY:

The approach considered most appropriate when exploring associations between variables, and has proved cost-effective for sampling respondents over a wide geographic area and in a short timeframe, is the survey (Oppenheim, 1996). The data collection instrument chosen was the questionnaire. Questionnaires have found wide application in educational research for gathering information that is not directly observable and for enquiring about feelings, motivations, attitudes, accomplishments and experiences of individuals (Borg & Gall, 1994). The validity and reliability of the questionnaires were established in a three-step process (Carmines & Zeller, 1979); namely, an extensive review of the literature, followed by the design of the questionnaires and their successive refinement.The sample was all such schools in Ireland (n = 742) and was directed at school principals, senior cycle physics teachers, and junior cycle science teachers. The student sample comprised of 529 university freshmen from NUIG and UCD who attended courses, which attracted students with a mathematical or technical aptitude.

RESULTS/CONCLUSIONS:

The comparative analysis of both teachers' and students' responses reveals that there is general consensus amongst all cohorts that physics is considered to be a difficult subject; the level of mathematics required for the study of physics for the Leaving Certificate is higher level; it is more difficult to obtain high grades in physics than in other subjects for the Leaving Certificate; physics is perceived to be a male dominated subject; students are not fully aware of the range of employment opportunities associated with physics. However, teachers and students adopt opposite positions in relation to: satisfaction with the content of the current Leaving Certificate syllabus (teachers agree); satisfaction with the balance between theoretical and practical work (teachers agree) and lastly satisfaction with the teaching and learning resources available in schools.

DISCUSSION:

The Irish economy would not have sustained the growth it experienced during the Celtic Tiger without the continued supply of highly educated science, engineering and technology graduates, which can no longer be guaranteed given the noticeable decline of interest in science throughout the Irish education system. The Report of the Task Force on the Physical Sciences (2002) confirmed the seriousness of this decline, expressed optimism that it could be reversed, and proposed a six-point action strategy to improve the situation.

Keywords: Physics Education; Physics up-take; Second-level Physics; Leaving Certificate Physics (Higher-Education entry exam); Higher Education Physics.

PS.05.08.W

Strand 2: Teaching Physics Concepts

Parallel Session 05.08 Workshop
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D406 (3rd Floor)

Charges and capacitors – hands-on minds-on approach

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The purpose of the workshop is to present practical classroom ideas concerning charges and namely capacitors to physics teachers and educators at high school or introductory university level. The ideas and experiments can be used also in pre- and in-service teacher training.
Though properties of charge and the forces between them in electrostatics are often introduced by means of clear and simple experiments in physics textbooks (for example in Chabay and Sherwood's "Matter and Interactions"), capacitors, their properties and the relation between charge, voltage and capacitance are usually presented only in a theoretical way. On the other hand, nice electrostatic experiments can be found in books on simple hands-on experiments (for example Ehrlich's "Turning the World Inside Out" and others) but these are usually mainly qualitative and do not form coherent teaching-learning sequence.
The aim of the proposed workshop is to offer teaching learning sequence using simple and low-cost experiments by which the concept of capacitors and capacitance can be introduced, the relation between charge, voltage and capacitance can be studied and the link between charge and current can be establish. Both qualitative and quantitative experiments will be presented, some of them a bit non-traditional and perhaps at least in some aspects new to the participants. The content of the workshop should provide inspiration and some new ideas also for those participating physics teachers and educators who could not or would not like to implement the whole teaching-learning sequence but just add some new simple experiments to their teaching on capacitors and charges.
The experiments and activities will include, among others:
- a hands-on experiment introducing the very concept of capacitance
- construction of simple capacitors (that will be later used in further experiments)
- experimental "discovery" of the formula relating Q, U and C
- measurements of charges without a charge meter (demonstrating the principle of a charge meter)
- investigation of charging and discharging of capacitors and, as an application, a model of a relaxation oscillator
- investigation of the behaviour of real relaxation oscillator with the integrated circuit 555
- finding the capacitance of various conductive bodies like cans – but also a human body

Only low-cost instruments and materials will be used; for quantitative measurements the ordinary cheap multimeters will be sufficient. All experiments presented at the workshop will be real experiments and all participants will be able to try them (to "put their hands on them"). The participants will also calculate some quantities connected to the measurements and discuss the behaviour and implications of experiments. Short written materials describing the experiments will be given to participants.
The workshop is based on the experience with part of the workshop "Capacitors and coils" for Czech physics teachers at the conference The Heureka Workshops 2011 and with in-service teacher training courses for physics teachers in Prague and labs for high school students that took place during the school year 2011/2012.

Keywords: teaching-learning sequence; capacitors; charge;electrostatics; low-cost experiments

PS.05.09.a

Strand 4: Laboratory Activities in Physics Education

Parallel Session 05.09
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D402 (3rd Floor)

Activities and Research for Attracting Girls and School Teachers to Physics by LADY CATS and Science Teachers Groups

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LADY CATS (LADY Creators of Activities for Teaching Science) is an organization of science teachers consisting of female staff ranging from primary to university.
Many schoolgirls have little interest in physics. Female physics teachers and researchers are in the minority in Japan. Recently, many primary teachers, especially female ones, are not so interested in physics or science in general and the number of young primary teachers who have not studied physics at a high school or college is increasing. Therefore, they are not comfortable with teaching the subject. Also, these teachers are usually too busy with other work to prepare for experiments, so consequently few experiments are performed in the classrooms. In addition there is not a lot of financial support for the extra-curricular activities of physics teachers.
In order to try to change this situation, we organized our group in 2004 at the ASE (Association for Science Education) and formed the "LADY CATS" group at the ICPE in 2005. We try to attract girls to physics and also support female teachers. Our work has progressed to support female physicists/scientists. Each year, our activities include collaborating with male science teachers abroad. These activities encourage female teachers to study physics education in spite of the often difficult social and/or culture factors, for example marriage, childbirth, parenting and taking care of their own parents. We try to draw male colleagues into our activities to gain their support and their understanding of our gender related problems.
We have taken over the “STRAY CATS” sprit and adopted part of their name.
The “STRAY CATS” are a Japanese high school teachers group. They demonstrated many experiments at international conferences for more than 20 years. These demonstrations from Asia achieved worldwide attention.
We would like to propose and exhibit beautiful and simple experiments that can demonstrate the principles of physics to inspire the students. They are not only visually appealing but will also help in their understanding of scientific ideas. These experiments are easily made and are low-cost. It is also our aim to try to catch female students’ eyes with these experiments and see physics from the female point of view. By this we mean showing them the “beauty” of physics. Furthermore, we believe that these ideas may help resolve gender related problems and would assist non-specialist teachers in primary schools.
In addition to the above points, we demonstrate how the principles of physics can strike the students’ interest. We also show the appealing and effective nature of low-cost materials that can be used in the teaching of physics. For example, a Geiger-Müller counter made from a film case, a triangular kaleidoscope from just a mirror, a sound motor from a paper cup, Faraday’s Motor from a wire and so on.
If you would like to make them, please attend our workshop.
We believe these issues would be a great first step to changing young people’s perception of physics.

Keywords: simple and low-cost experiments, attractive to children, teacher training, scientific experiments, gender problem

PS.05.09.b

Strand 4: Laboratory Activities in Physics Education

Parallel Session 05.09

Date & Time: 03.07.2012 / 14:10 - 15:40

Room: D402 (3rd Floor)

An Investigation of Prospective Teachers' Views on Implementing a Science Writing Heuristics in Physics Laboratories

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Inquiry research techniques are one of the crucial supporters of science laboratories. In many countries, science education standards and teaching curriculums emphasize the importance of research-inquiry, especially with regard to science education. One of the inquiry- and research-based learning approach is the Science Writing Heuristic (SWH) (Keys, Hand, Prain, & Collins, 1999) which was developed by Hand and Keys (1999) for learning purposes in laboratory activities.

This approach encourages scientific understanding through the power of writing. Writing–learning strategies in the SWH approach are primarily discussed within research-inquiry periods and interactive group activities. The SWH approach consists of two templates. One is the teacher template, which includes various activities that direct students to write, read, think meaningfully, and discuss the concepts related to laboratories. The second template includes numerous questions for the students to answer: (1) Beginning Questions-What are my questions? (2)Tests-What did I do? (3) Observations-What did I see? (4) Claims-What can I claim? (5) Evidence-How do I know? (6) Reading- How do my ideas compare with other ideas? (7) Reflection-How have my ideas changed? The SWH students' template can be considered an alternative instrument to the traditional report format. Hand and Prain (2002) indicated that there is a need for broad applications regarding the learning of writing strategies at different class levels. Günel (2009) stated that, in Turkish science literature, there is a gap in studying the effects of writing on the learning of science, which underlines the necessity to study writing as a learning tool. In recent years, only a few studies related to applications of the SWH have been conducted in Turkey, with the results of these studies reflecting the effect of the SWH approach on learning and learning permanence (Günel et al., 2010). When studies were analyzed, generally, it was evident that the studies focused on the effect of SWH on primary school students' achievement and their conceptual comprehension.

The purpose of this study is to examine science teacher candidates' opinions about the implementation of the SWH approach in General Physics Laboratory-I course. A total of 90 candidates attended from the 1st year science teaching education department. This study was carried out in three groups. Within the groups, the SWH approach was used in group1, the SWH approach with a peer assessment form was used in the group2, and a traditional laboratory approach was used in the group3. Teacher candidates in group1 and group2 wrote their lab reports according to the SWH student template, while the candidates in group3 according to traditional lab reports. The lab activities were conducted 9 weeks as two-hour sessions per week. All groups performed experiments on nine subjects about mechanics during the study. A rubric was prepared to evaluate the lab reports regarding the SWH templates. Each teacher candidates evaluated another candidate's template using the SWH rubric. At the end of the lab activities, semi-structured interviews were conducted with 34 volunteer candidates. A tape recorder was used during interview process. For the analyses of the interview data, first the audio recordings were transcribed in verbatim. Then, the data obtained from the interviews was evaluated by content analysis. As a result of the analysis, three main themes were identified: "opinions on SWH student template and traditional lab reports", "peer assessment" and "opinions on physics lab course". Most of the teacher candidates said that using SWH template in physics laboratory contributed them to express themselves, relating physics concepts with everyday life, understanding physics concepts, increasing success, and positive feelings towards physics. In conclusion, this study found that using SWH approach and template contributed to teacher candidates in many ways, and teacher candidates had positive opinions towards using SWH. The SWH approach, used as an alternative to traditional laboratory report writing formats and a lab approach can be applied to university students and teacher candidates in different laboratory courses and activities. Similar studies should be conducted on the effects of different variables.

Keywords: Physics laboratory, science writing heuristic, student template, teacher candidates

PS.05.09.c

Strand 4: Laboratory Activities in Physics Education

Parallel Session 05.09
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D402 (3rd Floor)

Degrees of freedom in physics laboratory work – teacher's and students' experiences

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Background, Framework and Purpose
In a Swedish context, the physics teachers are responsible for implementing new ideas for physics teaching and learning. The new syllabus Gy 2011 (Skolverket, 2011) gives guide-lines for central content areas and for important aspects that have to be included into the courses, but do not prescribe how to teach this content. The characteristic of science education that distinguishes it from many other subjects is that it includes experimental work - activities in which students will be able to handle equipment and making observations. In this study we describe and discuss how physics teacher and students experience working with laboratory work with different degrees of freedom. This study is part of an ongoing longitudinal PhD project on Laboratory Work in Transition in the Swedish Upper Secondary School in Physics.
Much research on laboratory work has been carried out in the last 40 years. The research and access to new technologies has contributed to the development of alternative forms of laboratory work in physics education. According to Sere (2002) closed laboratory work is still the most prevalent at upper secondary school in the majority of European countries. Abraham and Miller (2008) assert that practical work can be efficient significantly. Teachers and authors of educational materials need to realize that practical work requires that students make connections between the real world, materials, events and the abstract world, thoughts and ideas. Practical work plays according to Abraham et al. (2008), an important role in helping the student establish a link between observations and ideas. But these ideas must be introduced to the students and the interaction has to exist there during the activity. The study shows that few practical lessons are designed to stimulate this interaction The teacher must strive to find a better balance between "doing" and "learning" in practice. Sere (2002) found in the Labwork for Science Education (LSE) project the same thing, stressing the importance of further research in this area. Kipins (1996) saysthat the experiment as a demonstration is overrated but claims that labs designed in a student-engaging way can enhance learning. An increased focus on students' active participation by the new Swedish physics curricula makes the laboratory work content and its importance for learning of high research interest.
The Millar (2002) model was used as a part of the theoretical framework in this study. The model formed the basis for the analysis of observed laboratory lessons together with teacher's and students' interviews.
The main purpose of this study was to investigate teacher and students experiences working with different forms of laboratory work in physics and its importance for students' learning. This lead to following research questions:
- What opportunities and difficulties do the teacher and the students experience when they are doing laboratory work with different degrees of freedom?
- How does the design of the lab effect students learning?

Method, Setting
The study is an intervention in the sense that we asked a physics teacher to plan and conduct laboratory work lessons with different degrees of freedom. The teacher planed two different labwork lessons. One labwork lesson that was closed in its character and one that was open. The number of students participating in the study was 19. These students preformed the laboratory work in groups of 2-3 people at two different occasions. The teacher was interviewed before and after each session and the students in groups after each occasion. All documentations were done using video cameras.

Result, Conclusions and Implications
In this early stage of the analysis of the observations and interviews we can see that closed labwork are easier to perform both for the teacher and the students. The need for solid and deeper knowledge in physics, from both students and teacher are becoming more obvious in the open labwork. Also the outcome of the open lab is more dependent on the students' attitude and commitment to the task. The conclusion at this stage indicates that the result is in consensus with previous research in this field. The opportunities with the open labwork are several in comparisons with the closed labwork. Students who attend in open labwork have to apply their knowledge to a higher extent compared to in closed lab work activities. In open lab work students can immerse themselves in a field they think is interesting within the boundary set by the teacher. This doesn't mean that one form is better than the other. The open labwork imposes very high demands on the teacher and the students to ensure the procedure to be effective. The open labwork can easily become time ineffective and ending up with frustrating students.

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Keywords: Physics education, Laboratory work, Open labwork, Closed Labwork, Intervention

PS.05.09.d
Strand 2: Teaching Physics Concepts
Parallel Session 05.09
Date & Time: 03.07.2012 / 14:10 - 15:40
Room: D402 (3rd Floor)

Identifying the strong and weak points in students' schemas regarding kinematic graphs

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The study has uncovered a consistent set of schemas students have regarding kinematic graphs. According to the existing literature, students often possess weak patterns of association when they apply them to physics tasks. This weak association often implies fragmented sets of knowledge containing pieces of information that are inconsistent with one another. A strong pattern of association is characterized by pieces of knowledge that are frequently elicited together in a wide variety of situations. We refer to robust patterns of association as schemas. A schema is a set of coherent knowledge that is brought up in a set of similar contexts or situations. Schemas contain facts, rules, p-prims and other spontaneous responses that are used to accomplish a certain goal. Although schemas are not necessarily correct, the relations among the pieces of knowledge are important for us to identify if we are to understand how students reason. In addition, researches have shown that many students seem to lack the ability to use graphs for either imparting or extracting information. Part of the motivation for undertaking this study has been a conviction that facility in drawing and interpreting graphs is of critical importance to develop an understanding of many topics in physics.
Therefore, due to importance of both schemas and graphs in learning physics, we decided to analyze students' schemas about graphs to identify strong and weak points of their schemas. This awareness helps instructors to choose the best methods of using graphs which involves their schemas about position-time, velocity-time, and acceleration-time graphs. These graphs were analyzed based on misinterpreting graphs as pictures, slope/height confusion, students' problem with finding slopes of lines not passing through the origin, and their inability to interpret the meaning of the area under graph curves.
Bearing the above issues in mind, and having studied existing literature about student's problems with graphs, we devised a test which included 20 questions for this particular study. Some of These questions were selected from different valuable sources and others were developed by researchers.
Consequently, data from 40 senior high school students were collected and analyzed. Observing individual and group works and monitoring them while they were reasoning (e.g. what to do next) and supporting their argumentations on the test questions, as well as interviewing with each person, while they were asked to think aloud, were the means to depict student's schemas.
After analyzing answers (we examined each answer individually, and put it as a subset of one topic and then compiled them), we noticed students are not able to utilize the powerful tool of graphical analysis in physics. We expect them to know how to interpret graphs in terms of the subject matter represented. They should be able to choose the feature of a graph that contains the required information and to recognize a relationship that may exist among different graphs. They should be able to draw a graph of real situation and vice versa. The research shows their schemas lack the above shoulds and strong association. Furthermore, developing expertise in using graphs entails learning to use mathematics effectively as applies it in physics contexts, and although many students are strong in mathematics they cannot make sense of it in physics. Owing to the significant role of facility with graphing in helping students deepen their understanding of physics, comprehending their approach with graphs can help teachers to modify their instruction for a better learning to occur. The test used to collect the data is included in the complete article and should prove useful for other researchers studying kinematics learning as well as instructors teaching the material.

Keywords: Graph, Kinematic, Schema

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Bringing the world's largest science experiment into the classroom

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TU Dresden representing International Particle Physics Outreach Group

Since its start-up at CERN in 2008, the world's largest science experiment, the Large Hadron Collider (LHC), has intrigued millions of people worldwide. It has captured the imagination of the media and public alike in a way that only the Moon landings have done before. Communities across the globe are showing an increased fascination with current research aimed at answering fundamental questions about our universe.
Fundamental research about the origin of the universe and its fundamental forces and building blocks is an integral part of the culture of mankind, feeding the natural curiosity of where we come from and where we go. Most importantly, young people are being inspired to study not only physics at school, but science in general.
The International Particle Physics Outreach Group (IPPOG) has developed an educational activity that brings the excitement of cutting-edge particle physics research into the classroom. "International Masterclasses" provide an opportunity for high school students to be "scientists for a day." 15- to 19-year- old students in countries around the world are invited to a nearby university/laboratory for a day in order to take part in an authentic research process. Lectures from active scientists give insights into topics and methods of basic research in matter and forces, enabling the students to perform measurements on real data from the LHC. At the end of each day, like in an international research collaboration, the participants join in a video conference with CERN for discussion and combination of their results. International Masterclasses offer students the chance to experience modern science first-hand!
Today's science education has too few elements of modern research and direct contact to real scientific data and active scientists. The IPPOG Masterclasses are designed to address this deficit and have evolved over the past 7 years considerably, now reaching nearly 10000 students at more than 130 institutes in 31 countries across the globe over a 3-4 week period in the Spring.
The hands-on exercises that have been developed exploit real data and real analysis tools from 3 of the major experiments at CERN's LHC, known as ALICE, ATLAS and CMS. These inquiry-based learning exercises are well-documented in multiple languages and the tools can be installed easily and freely on any modern PC or Mac. Indeed many of the activities are web-based, requiring no software installation at all. And although the exercises are relatively simple in practice – identifying particles emanating from high energy collisions – they involve many basic physics principles (such as conservation of energy/momentum; motion of charged particles in electric/magnetic fields etc.) as well as probing some of the fundamental properties of elementary particles. These latter include an examination of the inner structure of the proton, the calculation of the masses of particles such as the "Z boson" and the "J/psi meson" and the identification of so-called "strange" particles. But it is not all about exploring the known world of particle physics! In some exercises a few simulated events are added to the mix, to allow the students to search for new physics – such as the "Higgs boson".
The reactions of both students and teachers alike to these analyses of real LHC data have been exceptional. The students quickly come to terms with the software tools and arrive at the underlying physics. Working in pairs, they discuss the graphical displays of collisions in order to understand what is being presented and then fill spreadsheets with their observations and measurements. Each pair analyses a different set of data, such that combinations of results can be performed – to discuss systematic and statistical errors, for example. The overall results from each institute are then discussed and contrasted with those from other groups, during the videoconference session at the end of the day – exactly as real scientists do!
Evaluations of the students, before and after the Masterclasses, have shown significant increases in their knowledge and enthusiasm – not only for particle physics but also for physics and science in general. Indeed even those participants who had already decided on non-scientific future studies/careers commented that their appreciation for science and scientists had improved.
We describe in detail the methodology employed for the IPPOG International Masterclasses, summarizing the hands-on activities physics analyses. We discuss the results of the evaluations and describe how others can participate in this worldwide adventure.

Keywords: particle physics, education, outreach, CERN, LHC, IPPOG, ATLAS, CMS, ALICE, inquiry-based learning

Informal learning in CLOE Labs to build the basic conceptual knowledge of magnetic phenomena

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Developing formal thinking and building conceptual knowledge as a background for formal interpretation of phenomena is one of the main challenges in teaching and learning physics (Michelini & Cobal 2001). In particular, this is evident when a phenomenon is interpreted by means of a quantity for which formal description is not directly related, to the aspects perceived, as in the case of the flux and its rate of variation in electro-magnetic induction phenomena. Similarly, in this case, where the phenomena is described by the flux variation in time in the magnetic field, the familiarity with and the knowledge of the phenomenology is a pre-requisite for the conceptual and formal interpretation. This is related to a gradual growth of phenomenological condition to its occurrence, the individuation of quantity involved in the electro-magnetic induction, and the phenomenological exploration at the primary and middle school levels is a must for this purpose.

Connection between scientific and everyday knowledge is one of the main problem of learning in scientific field (Pfundt & Duit, 1993). Pupils construct spontaneously their own models to interpret the reality, while observing the real world in everyday life (Gilbert, 1998). The role of experiences is decisive in the construction of knowledge (Duffy & Jonassen 1992). The presence of persistent conceptions in student's knowledge may constitute difficult barriers to overcome (Duit, 1991). It is therefore necessary, to design informal hands-on and minds-on workshop activities to involve students in the knowledge building process promoting conceptual change (Michelini, 2005). Research literature review, in physics education highlight the presence of several typical conceptual knots in the students' knowledge related to the concept of field. In static field, difficulties are related to: the concepts of field as a superposition (Rainson & Viennot, 1992), field representation (Guisasola et all, 1999) and the relation of the field lines with trajectory followed by bodies (Tornkwist et all, 1993). In dynamic field case, the relation between magnetic field and electric currents, the nature of field itself (Thong and Gunstone, 2008), the sources of field and the role of relative motion, Lorentz force and the presence of moving charges inside the conductor (Maloney et all, 2001). Indeed, students have difficulties in the determining the verse of the induced magnetic field (Bagno, Eylon, 1997).

Conceptual exploration orients the learning process and the Conceptual Laboratories of Operative Exploration (CLOE) were designed to study and then to reinterpret the single experiment, in the process of creating a global theory (Fedele et all, 2005).

The aims of the study are:

RQ1: How pupils identify and explore conditions to produce electro-magnetic interactions?

RQ2: Which sort of quantities are conceptual references for the pupils for the representation of electromagnetic phenomena?

RQ3: What kind of formal representations are adopted by pupils in the interpretative processes

Experimentation was done in informal context with 13 classes (primary & middle-school 6-13 years old). First phase was carried out as a semi-structured plenary discussion in a big group, it was focused to attract the student attention and create resonance between important aspects of phenomenology and students' naive ideas describing and explaining phenomena by using only simple words. Second, was carried out as a series of small experimental observations concerning simple example of interaction between magnet carried out by students with the support of an semi-structured inquired based discussion and it was aimed to introduce them, a early representation of the magnetic field line. Third phase was carried out in small groups; in this phase pupils had to face a real challenging task concerning the conditions needed to produce an induced electro-magnetic phenomenon. In this phase pupils had to interpret, taking into account all the observations that they had made in the second phase. Final discussion was focused on the creation of a general set of procedure and induction cases from which recognize the key points needed to give a global interpretation of the phenomena. Data was collected in the form of audio-video recordings, of the CLOE labs.

An important role of the partial and local interpretation of single experiment explored step by step emerge in building a global interpretation of the electro-magnetic induction phenomena, where interpretative aspects are recalled in an analogical way. Abstract entities are used during the learning path when inquired base hands-on and minds-on was carried out. The re-use of same quantities in a new framework is an additional gain of the coherent explorative chain in its own progress. For example, pupils refer to the property of the space surrounding the magnets, in few cases, a first representation of this magnetic property using compasses as explorer of the space, drawing a first representation of the magnetic field lines.

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Keywords: CLOE, Electromagentism, Magnetism, Electromagnetic Induction

PS.05.10.c

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International Masterclasses 'Hands on Particle Physics' - The Portuguese Approach

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The International Masterclasses in Particle Physics (www.physicsmasterclasses.org) are one of the very successful activities promoted by the International Particle Physics Outreach Group (http://ippog.web.cern.ch/ippog/), which involves thousands of high school students in more than one hundred institutes from dozens of countries.
The aim of the International Masterclasses Hands on Particle Physics is to bring high school students to universities to unravel the mysteries of particle physics. After analyzing real data collected at CERN, students from the institutes participating in that day, from the same or from different countries, gather together in a video-conference like in an international research collaboration, for discussion and combination of their results. For the first editions, the real data was collected by the DELPHI and the OPAL experiments at LEP/CERN, and since 2011 the real data is collected by the ATLAS, CMS, and ALICE experiments at the LHC/CERN.
Portugal participated in the launching of the International Masterclasses in 2005, celebrating the 2005 International Year of Physics, with 3 institutes and around 100 students. Since then the activity grew, and for this year's 8th edition in 11 sites, around 1800 students and 200 school teachers from North to South and from West to East are expected. Portugal is the country with more participants in the international program, and being Portugal a peripheral and small country (pop. 10 million people), these numbers are proportionally very large. Although the Portuguese program is financially supported by Ciência Viva Agency (www.cienciaviva.pt), we chose to move the particle physics researchers towards a closer university or polytechnic institution to co-organize such a day, so that the students no longer have to travel 200 km early in the morning to reach a participating institution. This has enabled us to greatly extend the reach of this activity, geographically as well as from the socio-economical viewpoint, namely also reaching the poorer and more isolated interior regions of the country.
One could think that for many students a school day at an University analyzing data collected at CERN is much nicer than being at the school working other disciplines. However in Portugal about 90% of the students are participating on Saturdays and, the fact that they exchange a leisure day towards a research work day, is also a measure of the excitement conveyed by this activity. The growth in Portugal, more than the evaluation questionnaire filled by the students at the end of the day, also tells us that students were very happy with the activity, and that have passed their excitement to their colleagues and younger brothers and sisters.
We thus believe that this program is a strong motivation flash to enjoy physics, to have enlightenment about what is physics nowadays, and to encourage young people to follow a scientific or technological career or, at least, to have a different view towards physics and towards research and technological challenges. Another point of interest is the fact that the event takes place in an international context, offering the student a live experience of how most research work is made today, not only in physics but in almost every discipline, due not only to the global nature of science, but also to the high cost of experimental installations.
In this presentation we evaluate the Portuguese case and the reasons behind its success, and how it can link and help other countries to profit from the International Masterclasses activity to increase the reach and engage more teachers and students in physics and science in general.

Keywords: Learning physics in informal settings, international collaboration, hands on

PS.05.10.d

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Parallel Session 05.10
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Students of the 21st century learning science: The use of Frankenstein and theater to teach Science and Philosophy

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This work tries to defend an interdisciplinary and transdisciplinary approach in Science Education to high school students. It has as its main goal to stimulate the reflection on possible contributions of events that articulate the theatrical language with the scientific practice in the processes of science learning. Through research, interviews and focus group we can realize that there is a new and efficient way to learn science. It presents a methodology that seeks a useful learning of science to life and to work in which information, knowledge, skills, abilities and values are real instruments of perception, interpreting, judging, acting, learning, satisfaction and personal development. It is proposed that theater presentations based on science and philosophy, managing scientific problems and concepts, should be a useful, enjoyable and effective way to learn.

Interpreting science and technology to a large and diversified audience is the main mission for our group of researchers. The changes that take place in society demand new approaches in the relationship with high-school students. We analyze how High School can reinvent the way through which science shapes its relationship with the community and with its identity as a knowledge center in the 21th century.

After the great success and public review of the two theatrical productions of Galileo (Brecht) and Oxygen (Hoffmann & Djerassi) with high school students, there was a concern of the group to show a critical view of science. Thus, it was chosen the novel Frankenstein by Mary P. Shelley. Adapted for theater by researchers, based on the translation by playwright David Herman, where they created various dialogues between the characters: Mary Shelley, Percy Shelley and Lord Byron discussing philosophy of science, naturalism, faith, reason, origin of life, religion, so that viewers could understand what and by whom the criticisms of science in the story were made.

In our school, there is a good dialogue among teachers of physics, philosophy and history. Teachers weekly talk about which approaches will be used to present the contents of the subjects. They seek harmony and integration among the topics. This procedure arouses students' larger interest in knowledge, making it possible to show science as a human construction. As a matter of fact, it was a kick start of our Theater Company - NUTEC - Nucleus of Theatre and Science – in 2007, which every year performs theater presentations, all of which covering topics on science.

In 2010 and 2011 we had an audience of more than a thousand students to see the play "Frankenstein". We did a research on students'/actors' conceptions about science before the beginning of the project and after the presentations in order to contrast their views on the importance of science today. In particular, we are always interested in surveying their previous conceptions about the nature of science and the changes produced during a contextualization that brings students closer to science learning, taking into account the historical and philosophical dimensions of science.

This research is a continuation of one on master's dissertation of a Brazilian professor who used references such as: Science Education Now: A Renewed Pedagogy for the Future of Europe (CE), the "Delor's report" (Commission Internationale L'Education Sur Vingt et Pour Le Siecle Unieme) texts by Charles P. Snow, Paulo Freire, Edgar Morin, Paul Feyeraband and Baserab Nicolescu.

On the last stage of our research, we concluded that the awareness and understanding of concepts covered in physics, philosophy and history of science through reading and discussion during rehearsals and theatrical interpretation experience performed by the students were very useful, delightful and consistant for science learning, much more than "talk-and-chalk" lectures.

Keywords: Science Theater, Interdisciplinary, Philosophy of Science, Learning in Informal Settings

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Undergraduate Research: What is it?

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Undergraduate research is now widely seen as one of the major paradigms for engaging students. In fact, at least in US, undergraduate research opportunities have become a common expectation of almost all incoming students and their parents. As a result, many universities now explicitly advertise the various ways they would engage incoming students during their undergraduate years.
At Loyola, we now have a highly developed structure for involving students through project based learning. We require that all of our students participate in at least one-semester-long undergraduate research experience, however, many do much more. In particular, I will describe an innovative Freshman Research Projects program that we initiated at Loyola in 1996, and have been continuing without break, for last sixteen years.
This program was developed to engage students into deeper learning by involving them into research projects. These projects serve several goals. First, they allow students to explore a single problem more deeply by engaging in research than is generally possible through a regular lecture-based course. Second, students working in small groups develop closer relationship with other physics majors and faculty members. This experience instills a sense of community among our majors. Furthermore, the hands-on experience of “doing physics” has a positive effect on the retention of students beyond their first year. Third, students, in collaboration with their faculty advisors, choose viable topics that match their interests and can be accomplished within a given budget. Thus, with the freedom to design their own projects, they are taking charge of their own education, and are encouraged to think creatively. Fourth, the relationship they form with their adviser helps many students to go into more advanced research in later years. Finally, these projects offer our students an experience in oral and written presentations, and introduce them at an early stage of their scientific careers to the realities and excitement of exploring physics. Frequently, these projects blossom into publishable research for juniors and seniors, and allows them to present their work at local and national meetings of relevant professional societies.
As is well known, these are very time consuming endeavors. Most universities do not yet have a mechanism to give the appropriate credit to students and faculty members for their tremendous work in running these projects. I will describe some of the steps we have taken to incentivize these projects, and to allocate proper credit to students, as well as their advisers.
For explicitness, I will describe some of the projects students have carried out over the years, and especially those that led students toward more advanced research.

Keywords: Undergraduate Research, Project based learning

PS.06.01.a

Strand 1: ICT and Multi-Media in Physics Education

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Authentic Problems for authentic assessment in Physics Education

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The Institute of Physics Education at University of Cologne is engaged in developing frameworks for learning science in meaningful real-world contexts. Sample contexts are Climate Change, Road Security and Disaster Relief.

The Framework relies on an ICT Platform (ILIAS, http://ilias.de) to deploy supporting materials, to connect learners and teachers in different schools, and to provide a network of experts that raise authentic problems and support authentic data for research.
Students are required to provide sound solutions, data-driven and grounded in theory, for real-life problems. Examples of good solutions can be uploaded and displayed within the ICT Platform.

A sample project within this framework is "Crash Kurs NRW". This is a State-Wide Programm in North Rhine-Westphalia (NRW) where Policemen, Paramedics and Firemen visit Schools and present authentic reports of car accidents to a large audience (>200). Accidents are chosen to be local, and to involve young drivers, which make them relevant to the young audience. In the follow-up lessons, students analyse the causes for the accidents, which typically cover speeding, drug abuse, distraction, or improper use of safety belts. Thus, the reasons of all accidents can be argued using proper scientific reasoning. After analysis, students are are encouraged to develop measures (videos, campaigns or posterwokshops) to inform peers to avoid the sources of accidents that they have just described. The course examples on http://www.crashkurs-nrw.uni-koeln.de show example lessons, aiding ressources, and video footage for in-service teacher training. Additionally, the server is used as platform for project evaluation. Questionnaires are provided online, facilitating anonymous survey and automatic real-time analysis and representation.

In the presentation, data of the crash kurs NRW Pilot Study with 6 Police Departments, 18 Schools and 1400 Students in a pre-post study are shown and discussed.

Keywords: authentic assessment, meaningful, context, physics, education, traffic, physics of traffic, cooperation, challenge based learning, problem based learning, motivation, Nature Of Science

PS.06.01.b

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 06.01

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Fostering pre-service science teachers' TPCK and computer self-efficacy beliefs in teaching middle school physics subjects

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The purpose of this study was to explore development of pre-service science teachers' Technological Pedagogical Content Knowledge (TPCK). A cohort of 30 pre-service science teachers participated in this study in their sophomore years. The participants were enrolled in a technology and design course, in which they worked in small groups, during the study in spring semester 2010. For research and data collection purposes elementary school physics units were utilized in order to monitor the development of participants' TPCK. During the course, a special attention was paid to foster participants' TPCK. The Research Questions were as follows:

I. What is the pre-service science teachers' perceived confidence level on four TPCK constructs (i.e., Technological knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and TPCK)before and after technology supported physics teaching?

II. What is the effect of technology supported physics teaching on pre-service science teachers' computer self-efficacy beliefs?

III. What kind of changes occur in five TPCK construct as pre-service science teachers plan and implement technology supported physics teaching?

Mixed methods research methodology was employed in this study. One-group, pretest-posttest design was used to examine the TPCK development of an entire cohort of 30 pre-service teachers. The quantitative data were collected by the "Microcomputer Utilization in Teaching Efficacy Beliefs Instrument" (MUTEBI) (Riggs & Enochs, 1990) and "TPACK in Science Survey" (TPACKSS) (Graham, Burgoyne, Cantrell, Smith, Clair & Harris, 2009). Both quantitative and qualitative data were collected in order to inquire the nature of the development of pre-service science teachers' TPCK. The qualitative data were collected in order to probe deeper the process of development under investigation. For this purpose three pre-service science teachers were selected. They developed a lesson plan and taught selected topics from the primary school science curriculum. The findings stemming from the quantitative data show that technology supported physics teaching fostered the pre-service science teachers' TPCK confidences and their self-efficacy beliefs towards microcomputer utilization in teaching (MUTEBI).

To address the question of changes in TPCK occurs as pre-service teachers participate in technology supported physics teaching qualitative data was used. Pre and post interviews, observations during technology supported physics teaching and artifacts (lesson plans, technology supported physics teaching feedback surveys, and technology enriched science modules) were analyzed according to three components of TPCK. Moreover, the findings emerging from the three multiple holistic cases reveal that engaging in technology supported physics teaching fosters four of the components of TPCK (namely, knowledge of; purpose, curriculum and curriculum materials, instructional strategies and assessment, teaching with technology). However, due to the nature of the study, such engagement did not foster teacher knowledge of students' understandings, thinking, and learning in science with technology which is one of the five components of TPCK. It is concluded that technological knowledge, pedagogical knowledge and content knowledge are required for the development of technological pedagogical content knowledge. Furthermore, it is found that TPCK confidence, self efficacy beliefs towards computer usage in teaching, professional experience and academic success is effective factor for the development of technological pedagogical content knowledge.

Keywords: Technological Pedagogical Content Knowledge, Pre-Service Science Teachers, ICT, Technology Supported Physics Teaching, Mixed Methods Research

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Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 06.01

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Mastery Blended Learning: Achieving Breakthrough in Learning Physics

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Physics has always been perceived as a difficult subject to understand and master by high school students. The purpose of this study is to investigate the effectiveness of a new approach for teaching and learning Physics at the pre-university level (equivalent to grade 11-12 for the U.S. and Australian education systems) that is based on the concepts of blended learning and mastery learning.

Blended learning, popularly defined as the combination of elearning with face-to-face facilitation, is becoming more common in institutions around the world, including high schools and institutions of higher learning. Blended learning aims to combine the advantages of elearning and face-to-face interaction, so that it becomes potentially more powerful than solely using one instructional approach. While blended learning might enhance learning, how do we then ensure that all students achieve good understanding of the subject matter? The answer lies in mastery learning, a strategy that aims at getting students to achieve a certain pre-set target of high competency.

In this study, the strategies of blended learning and mastery learning (termed as Mastery Blended Learning in this study) are integrated as an innovative approach to improve students' understanding and performance in Physics. Six randomly chosen pre-university classes (154 students at grade 11) of mixed ability pre-university students taking the subject Physics at G.C.E. Advanced Level participated in this study. Three of the classes (77 students) were randomly chosen to be the experimental group while the other three classes (77 students) to be the comparison group. Both the experimental and comparison groups were taught by the same group of teachers. The content of the curriculum is the same for both groups, covering the topics of Gravitation, Oscillations and Waves, for a period of 3 months. The only difference is the approach being employed, with the experimental group using the Mastery Blended Learning approach and the comparison group using traditional classroom teaching.

For each topic, students using the Mastery Blended Learning approach were taught with more ICT tools and had to attempt practice quizzes which provided instant feedback that were related to the questions to help them master the topic. The main distinction between typical online tests and the online Mastery Learning quizzes lies in the quality of the feedback: most online tests would only provide brief explanations and solutions for the questions, while the Mastery Learning quizzes provide more, including detailed explanation of the concepts with the use of videos and other online resources.

To assess that the students understanding, they had to sit for an online Mastery Learning Test, which consisted of questions that were different from the quizzes but assessing them on the same concepts. They would be considered as achieving "mastery" if they achieved as a score of at least 80%; otherwise they would need to review the feedback and learning tips from the quizzes and the Mastery Learning Test to gain a better understanding of the concepts, before sitting for a Mastery Learning Retest after class hours. They would repeat this process until they had achieved "mastery" for the topic.

The students in the comparison group also took the Mastery Learning Test, as a summative assessment, except that they did not go through the whole mastery learning process described above. They were also not provided with the instant feedback (although the teachers went through the questions with them and provided them with "delayed" feedback in class).

The effectiveness of the Mastery Learning approach was investigated and discussed in this study. The analysis of covariance (ANCOVA) was used to determine if there was any significant difference between the performance of the two groups. On the whole, the experimental group was found to perform better than the comparison group and the result was found to be significant at the 0.05 level.

Keywords: blended learning, mastery learning, physics, ICT, elearning, face-to-face, G.C.E. A-level, high school, gravitation, oscillations, waves

PS.06.01.d
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Realizing Authentic Inquiry Activities with ICT

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We report on our research and development work, recently presented in a PhD thesis (Heck, 1012), about the role of an integrated computer learning environment in mathematics and science education. We present the main results of the PhD study, which was driven by two questions:
(1) how can ICT contribute to the realization of challenging, cross-disciplinary practical work of good quality, in which pre-university students develop mathematical and scientific literacy? (2) What kind of tool-based environment could support inquiry-oriented science education.
In most case studies and field experiments, pre-university students carried out quantitative mathematical modeling activities using ICT, i.e, they explored mathematical models based on physics principles with the support of ICT tools in order to come to grips with natural phenomena and to interpret real data. In many school projects, students could apply ICT for doing research in a way that resembles research by scientists and practitioners. This has resulted in better understanding of the ways in which ICT can support students in carrying out an inquiry activity and can reduce the gap between research of students and professionals. In addition, more insight was obtained in what it takes to develop an integrated computer environment for mathematics and science education. The students used in their research the software and hardware environment COACH, which originated at the University of Amsterdam and which is popular in secondary science education.
The students' inquiry activities were amongst others about human locomotion (walking, skipping, running, …) and other subjects in movement science, sports science, quantitative pharmacokinetics, and analysis of digital images and video clips. It turned out that students can autonomously do interesting research projects and obtain results of good quality that are comparable with results published in scientific or professional journals. The attached picture is a screen showing the experimental setting in which COACH has been used to record on video the vertical bouncing of a pupil on a jumping stick, the spring-mass model of the vertical motion, and the comparison of model results with empirical data. The spring-mass model turns out to work also well for human vertical hopping and it forms the basis of modeling bouncing gaits like hopping forward like a kangaroo. The latter successful modeling of human gait has brought the student work close to a high scientific level.
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Keywords: science education, educational technology, authentic inquiry-oriented student activities, quantitative mathematical modelling

PS.06.02.a

Strand 2: Teaching Physics Concepts

Parallel Session 06.02
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D405 (3rd Floor)

Students' Conceptions About the Topic 'Radiation' - Results from an Explorative Interview Study

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Students' conceptions have been and continue to be a major issue in physics education research. The ideas that students bring to the physics classroom are considered to be of high importance for their learning results when following a constructivistic approach. The on-going discussion about empirical research results and the theoretical framework of students�much conceptions are best described by Duit et al. (2008). A lot of research results have already been accumulated in the field of students' conceptions about various topics. The bibliography STCSE compiled by Duit (2009) gives a good impression of the abundant studies in numerous fields such as mechanics, electrodynamics, and optics. For the topic „radiation", however, only very few studies about students‛ conceptions can be found. In addition to that, the majority of those studies investigated students' conceptions about nuclear radiation and date back to the 1990s. There are very few studies that focus on other types of radiation or the term "radiation" in general. As students of today are confronted with the term "radiation" in a lot of contexts (e.g. mobile phones, tanning booths), it could be assumed that the conceptions students have in this field of physics might have changed over the last decades.
As a consequence, our explorative study aimed to investigate associations and ideas that students have regarding radiation, a term widely used in various fields and necessary to understand fundamental ideas in science. We used semi-structured interviews to examine the perceptions of 50 high school students. The students were 14 to 16 years old and were chosen from 7 different high schools in an urban area in Austria. Following an interview guideline, students were asked about their general associations with the term "radiation" as well as about their general understanding of different types of radiation. The interviews were recorded, transcribed and analyzed using the method of Flick (2009).
The analysis of the interviews revealed that the students' associations were, to a great extent, very different from the scientific use of the term. The majority of the interviewed students associated the term „radiation" exclusively with nuclear radiation and also described the feelings that came up as mostly negative. Some frequent conceptions about radiation found in our study included the idea that radiation is always artificial and should be avoided by any means. Also, the majority of the interviewed students thought that all electrical devices (even MP3-Players and computers) emit radiation that can cause cancer. Hardly any of the students knew that light is also a type of radiation. Furthermore, very few students seemed to be familiar with the concept of thermal radiation: The idea that all objects emit radiation seemed to be implausible to the vast majority of students.
Considering the fact that several of the students‛ conceptions that we found in the interviews turned out to be inconsistent with the scientific concepts, we feel that these results should also be communicated to teachers. Our presentation, thus, will also include advice for teaching the topic "radiation" in science lessons, based on these preconceptions.

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Duit, R., Treagust, D., & Widodo, A. (2008). Teaching science for conceptual change: Theory and practice. International handbook of research on conceptual change, 629-646
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Keywords: students' conceptions, radiation, interviews

PS.06.02.b

Strand 2: Teaching Physics Concepts

Parallel Session 06.02
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D405 (3rd Floor)

Teaching different aspects of light in the unified framework of quantum mechanics

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In this paper we address the teaching of different aspects of light in a unified framework and non traditional way, for high school students. Our goal is to show how the quantum theory of light is able to describe different phenomena observed. That is, show the universality of these laws. For this, in a first part, we present a series of experiments showing different characteristics of light. In a second part the laws of quantum mechanics for light are presented and adapted to the mathematical level of high school students. Finally, in a third part, we show how the laws of quantum mechanics describe the observed phenomena.
This study is characterized by a careful choice of language used, especially with terms like "photon" or phrases like “particles of light” or “wave-particle duality”, that might be confuse for the students in a first stage. The same is noted for the experiments shown and graphic representations used. Specifically, for the first part, i.e. the presentation of experimental results, three experiments are shown.
The first one is a beam of light reflected on a mirror, where might be possible to assign the light characteristics associated to particles. The second one is the double slit experiment with light, where the interference pattern formed on the screen exhibits wave-like characteristics. Finally, to questioning the wave or corpuscular character of light, we present a sequence of real images of the interference pattern formation in the double slit experiment, with very low intensity light. The idea is that students notice that there are individual detection events and that the light hits the screen in granular form, a result that could be associated with the impact of "particles". At first, the individual events seem to be distributed randomly over the screen. But as time goes on, an interference pattern of maxima and minima, characteristic of wave behavior, is formed on the screen. In this case the light exhibits a behavior different from previous experiences: some particle-like aspects such as detection of individual events on the screen (which also occurs in the process of light emission by the source), and other wave-like aspects as the interference pattern formed on the screen.
We consider that previous sequence is a good teaching strategy to show that it is not possible to associate the light with purely ondulatory or purely corpuscular aspects and therefore we can not reconcile the concept of light completely with everyday concepts of wave or particle. We want to emphasize to students that this peculiar character of light called "quantum behavior" not only occurs in the case of light, but also in what we ordinarily consider as "matter" e.g. electrons [1,2].
Regarding the second part, i.e. the presentation of the laws of quantum mechanics, we consider the formulation of multiple alternatives (path integrals) of Feynman. To simplify this formulation and adapt it to high school level we use graphic representations and basic operations with vectors, which capture the essential aspects of the theory [3,4].
Finally, for the third part, we apply quantum mechanics laws by means of graphical methods to describe and predict the different experimental results initially considered. In particular we propose to discuss with students the law of reflection from the point of view of sum of all alternatives to determine that “classical” minimum time path (Fermat's principle) is not the only one possible, although the most likely. In the same way, we reconsider the double slit experiment in quantum terms. It allows incorporating naturally the statistical aspect of the phenomenon, and to describe a "wave behavior without waves", i.e. describe the interference phenomenon bypassing the traditional explanation by means of wave optics (Maxwell equations), as it is traditionally addressed.
The proposal presented here will soon be implemented in high school students (16-17 years old), after construction and testing of a sequence of situations that we are developing. It is essential the analysis and discussion of educational and cognitive aspects before and after implementation to promote meaningful learning of the concepts involved.

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Keywords: quantum, light, Feynman, paths, teaching

PS.06.02.c
Strand 2: Teaching Physics Concepts
Parallel Session 06.02
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D405 (3rd Floor)

Quantum physics education enlightens physics education

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A lot of difficulties that aroused in interpreting quantum physics from its very beginnings are still at the core of most educational presentations today.
Physics theories are knowledge organizers that generate more knowledge1.
Here we argue that most of the reasons of the previous difficulties mainly lay in the lack of consciousness about the proper and exclusive nature of the theories, rigorously identified with their formalism and interpretation2,3.
Due to this lack of consciousness, usually people try to grasp theoretical concepts by referring to a blend of ideas taken from other physical theories to which they, furthermore, add up pre-science and common sense schemes.
In the developing of quantum physics at least three steps can be singled out. 1) Old quantum physics: that is facts and interpretations from 1900 till about 1925 with the background idea of the existence of the so called quanta. 2) Quantum mechanics: it is a non-relativistic theory with well defined axioms that describes the behavior of a finite number of interacting particles. 3) Quantum field theory: it is a relativistic quantum theory, and as it is well known every relativistic quantum theory will look, at sufficiently low energies, like a quantum field theory4.
In this work we will take as examples some well known difficulties in quantum physics education that derive from mixing these three parts together with great ingenuity and mostly focusing on old quantum physics. Even paths that do not follow a (pseudo)historical approach, often lack a crucial point: that the meaning and the "reality" of the quantum world can only be understood from the interpretation of the theory equations. This aspect is by no means typical of quantum physics, but is common to nearly every physics concept. For example the meaning of the concept of force is to be stressed from newtonian mechanics and the "reality" and proprieties of the electric field can only be be understood from Maxwell equations5,6.
But, in a sense, in quantum physics we are in a more lucky condition because theory is so clearly and deeply at the heart of our quantum knowledge, that we cannot "escape" from it. Therefore the work done for an educational reconstruction of quantum physics can help us not only to find more useful teaching strategies, but to shed light on classical physics education as well.

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Keywords: Quantum physics education, theories, common sense schemes

PS.06.02.d

Strand 2: Teaching Physics Concepts

Parallel Session 06.02
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D405 (3rd Floor)

Alexander Graham Bell and the assassination of US President Garfield: Teaching the physics of early attempts at medical imaging

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In an assassination attempt, United States President James Garfield was shot on July 2, 1881. A bullet was lodged deep in President Garfield's body. Knowledge of location of the bullet was needed quickly to decide on the medical treatment required to save Garfield's life. Alexander Graham Bell proposed that he use his newly invented telephone and another relatively new development, the induction balance, to locate the bullet. [1] The induction balance involves four coils of wire that are placed in a circuit so that the current "balances," somewhat similarly to a Wheatstone bridge for resistances. Bell did not have alternating current available so he obtained a changing current with other methods such as pulses generated by a microphone that was located in front of a ticking clock. If the current became unbalanced, Bell would hear a signal in the earpiece of his telephone. Bell's device was, in effect, the first metal detector and the first attempt at medical imaging inside a body without surgery. His device successfully detected metal in carcasses of animals and in United States Civil War veterans but the attempt to find the location of the bullet in President Garfield was not successful. A combination of scientific, political, and personal reasons led to Bell's failure. [2] However, the scientific aspects provide a good way for students learn several concepts in electromagnetism and AC circuits. One such laboratory exercise has been created. [3] The context of the first attempt at medical imaging should be motivating to medical students who are studying physics. We have completed a lesson which involves both hands-on and computer simulations to help students understand the foundations underlying Bell's idea, why it should work, and why it failed. In our experiment we have updated the technology. Thus, we use signal generators and, sometimes, oscilloscopes to create and detect the signal. The Soundcard Oscilloscope software has been quite useful for this experiment. [4] The lesson provides the basic understanding of Bell's attempt and the use of physics in this early attempt at non-invasive medical imaging.

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Keywords: electromagnetism, teaching, medical physics

PS.06.03.W
Strand 3: Learning Physics Concepts
Parallel Session 06.03 Workshop
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D406 (3rd Floor)

Inquiry SKILLS for physics classrooms

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Science teaching has always been conjugated by inquiry learning ever since the famous reform started back in 1961 when Bruner published his report called "The Process of Education". The concept of 'process vs. content' was invented for science curriculum development such as SAPA(science as a process approach). Process skills included discovery learning which later was changed to guided discovery and finally by the end of 1980's everybody accepted inquiry learning to be the basis of science learning. Defining specifically the inquiry skills which could be useful in the classroom became a major issue in science education.
We have defined a useful taxonomy for the inquiry skills in the classroom.
The domains of this TAXONOMY include:
A- Data collection
B- Concept formation
C- Research and validation
D- Problem solving
E- Scientific communication
F- Critical thinking
Each domain includes specific inquiry skills. For each inquiry skill, we first give a clear definition and introduction which is based on the science education literature.
Then exemplars and non-exemplars for each skill is given in a way that the classroom teacher would know exactly what to do to elicit that skill from the student.
A very brief description of the inquiry taxonomy is given here which is then followed by the details of one skill, say observation skill. More details will appear in the full paper which will be printed and distributed during the workshop.
I-DATA COLLECTION
This is normally and naturally the beginning of all the inquiry activities we perform in order to reach a comprehension of some science phenomena or concepts. This domain has six subcategories.
1-1. Observation: Obviation means sensing things around you by seeing, hearing, touching feeling or smelling objects and / or the environment for obtaining information.
1-2. Definitions: Clarifying definition is describing the terms or symbols or clauses we use in our scientific community. It is something like a DICTIONARY, or HANDBOOK.
1-3. Measurement: Finding a quantity for a given observation variable is measuring it. Measurement usually ends up finding a numeric value for a variable.
1-4. Using Tools: This skill defies the ability for utilizing science instruments and tools.
1-5. Collecting and Keeping Data: Whatever you do to collect, organize, and save your scientific data comes into this category.
B- CONCEPT FORMATION
Before going to problem solving or hypothesis testing, you should have enough comprehension-categories.
2-1. Categorizing: This is the ability to assign a category for each group of objects or items according to a defined scheme, like saying that the earth consist of PLANTS, ANIMALS, HUMAN BEINGS, SOLID and LIQUID.
2-2.Classifying: Classifying is categorizing things with hierarchy, i.e., class I is lower than class 2, and … so on, for instance
2-3.Inference: Inference is making conclusions via indirect observation. For example deciding on what can be inside of a close box by shaking it, weighting it and touching it without opening it.
2-4.Reasoning: Reasoning is explain the reasons behind doing something, or finding the causes.
2-5.Predicting: Predicting is giving information about the future events.
2-6.Cuing Question: This is usually the second question a teacher asks after getting the student's response to his first question.
C-RESEARCHING VALIDATING
This domain has 9 sub categories which includes making and testing empirical and theoretical hypotheses. This part is in fact the juice of scientific research.
3-1. Making empirical hypothesis: This type of hypothesis can be tested practically. It is a proposition about some variables which can be tested and be approved or be rejected.
3-2.Testing empirical hypothesis: This includes all the plans you make and all the activities you do to examine an empirical hypothesis
3-3. Data analysis: Organizing and analyzing your collected data to obtain results is called data analysis
3-4. Empirical validation: This skill includes all the practical activities you do to validate an assumption or prediction or hypothesis without actually testing it. It can be anything but testing.
3-5. Theoretical validation: Exactly like 3-4 but "theoretical" instead of "practical"
3-6. Making theoretical hypothesis: Just like 3-1, but theoretical. This type of hypothesis cannot be tested

physically and practically
3-7. Testing theoretical hypothesis for helping to: Just like 3-2 but theoretical instead of practical
3-8. Design of experiment: Designing simple experiments to do science works.
D- PROBLEM SOLVING
4-1. Identifying assumption: This skill includes finding whatever is known or given for solving a problem.
4-2. Identifying specific question: Finding exactly what you are to find in a problem.
4-3. Identifying alternatives: These are the possible ways and methods for finding the solution.
4-4. Simplifying the problem: This skill consists of eliminating unnecessary complexities for helping to solve the problem.
E- SCIENTIFIC COMMUNICATION
5-1. Giving explanation: Providing enough description for a scientific project.
5-2. Defining connection of data to RESULT: The results must come directly out of the collected data.
5-3. Preparing reports: Scientific project must have a standard report
5-4. Communicating reports: The reports should be in such a way that can be sent to other people red and examine.
F- CRITICAL THINKING
This is the ultimate skill of scientific inquiry. We have not been able to break it into sub skills but have general description.

Keywords: Inquiry skills, physics classroom, concept learning, problem solving

PS.06.04.a

Strand 6: Secondary School Physics

Parallel Session 06.04

Date & Time: 03.07.2012 / 16:00 - 17:30

Room: D402 (3rd Floor)

Comparison of Cognitive Conflict on Peer Instruction by Middle School Science Gifted Students and Non-Gifted Students

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In view of constructivism, students construct their own concepts by various experiences, and with constructed concepts, they participate in learning processes. Also, through interaction between diverse external information or environmental factors, they would change their concepts, so learning means changing concepts. As requisites of changing concepts, there are many researches on various teaching strategies which cause cognitive conflict. The key point of strategies of cognitive conflict is presenting discord situations and bringing about cognitive conflict. The purpose of this study is to inquire characteristics of changing cognitive conflict of science-gifted students by implementing peer instruction and causing cognitive conflict with concept tests, and then measuring cognitive conflict after peer-discussion, when they were faced to discord situation. To achieve this, I carried out a survey of 35 the 7th grade science-gifted students in the organization affiliated with education office in Seoul and Gyeong-gi province, and the 8th grade science-gifted students, and 71 the 8th students. They performed peer instruction on propagation of straight light and composition of light and then, discussed three concept problems. After discussing the students took paper pencil test about changing levels of cognitive conflict. Regardless of difficulty, the science-gifted students showed meaningful decreased figures on cognitive re-evaluation factors after peer-discussion. They trusted their peers, so during discussion, they explained their concepts. Furthermore discussion process enabled them to do reflective thinking. Consequently, discord of students dropped, and total figures of cognitive conflict also declined. Science-gifted students have a tendency to worry lower than general students, though they felt anxiety as difficulty of the problems after peer-discussion. Through peer-discussion, science-gifted students presented statically decreased anxiety factors. With above results, I acquired the implication that peer instruction can effective teaching-learning strategies which bring about cognitive conflict to the science-gifted students and through peer-discussion, and it enables them to focus on thinking, helps understand concepts. Moreover, by means of analyzed results of changing cognitive conflict of science-gifted students, developing and adapting strategies of cognitive conflict considering learner characteristics of science-gifted students is needed.

Keywords: Science Gifted Students, Cognitive Conflict, Peer Discussion, Light propagation, Item difficulty

PS.06.04.b

Strand 6: Secondary School Physics

Parallel Session 06.04
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D402 (3rd Floor)

Documenting the range and strengths of alternative conceptions harbored by junior college students in gravitation through the use of a novel 4-tier diagnostic instrument

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The topic of gravitation often poses learning difficulties for students in terms of comprehending its nuances and intricacies when it comes to conceptual problems. Examination of the literature shows that there have been only a limited number of studies on students' understanding of gravitation. The number of alternative conceptions that have been reported by researchers has thus been rather modest. For these alternative conceptions, no attempts have been made to document their strengths. Knowledge of the strengths of these conceptions would enable instructors to judiciously prioritize instructional intervention. In this study, we used a novel 4-tier diagnostic instrument to study students' conceptual understanding of gravitation. A total of 20 questions in the stated format were used. The 4-tier instrument, which was introduced in the science education literature in 2010, with the topic of waves as its focus, comprises a stem, answer and reason tiers, plus associated confidence ratings for each of these tiers. As the instrument is a diagnostic test, we restricted the questions to conceptual aspects of the topic. The confidence ratings allow for metacognitive monitoring of students' understanding of the conceptions. As a result, variables such as confidence when correct, confidence when wrong, confidence discrimination quotient, and confidence bias for the alternative conceptions can be calculated. Our study used a sample of 200 junior college students (Grade 12) and we identified over 20 alternative conceptions on gravitation, with most of these not having been reported in the literature. We report on the development and validation of the instrument, the various alternative conceptions identified, the strengths of these conceptions, and associated psychometric measures. Overall, we find that students' understanding of the conceptual aspects of gravitation is rather weak. Some implications of the study are highlighted, and a case is made that teachers can make use of such diagnostic instruments to better understand their students' conceptions on other topics in physics.

Keywords: 4-tier diagnostic instrument, gravitation, alternative conceptions, metacognitive monitoring

PS.06.04.c

Strand 6: Secondary School Physics

Parallel Session 06.04

Date & Time: 03.07.2012 / 16:00 - 17:30

Room: D402 (3rd Floor)

The role of girls in balancing boys' engagement in investigative physics high school activities

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Over two years, we investigated different aspects of teamwork in grade ten high school physics classes within a research program on uncomfortable but productive educational situations. We observed peer student clusters working in classroom activities and paid attention to Learning Opportunities seized by the students. We looked for tensions present in peer cluster interactions there because we considered them representative of tensions that are not explicit or conscious in everyday classroom. This study highlights the role of some girls in their peer cluster. Our observations allow us to perceive the way these girls acted when the boys of their peer cluster expressed hegemonic predispositions oriented towards domination, competition and power struggles. In our analysis, regardless of the proficiency level or conceptual grasp of scientific content these girls demonstrated, their intervention gave their group more favorable conditions for creating learning opportunities when compared to conditions of the groups where there was no one who would act the same way towards that sort of hegemonic provision.

The analysis of girl-boy interactions within teamwork in the light of a social theory of gender revealed different patterns of resistance, power relations and collaboration in each group. The research methodology counted on the gender theory as its analytical framework for accompanying classroom events from an ethnographic perspective. Three tenth grade high school classes were followed systematically along all physics sessions over a year. That allowed us to sketch a profile of each girl and each boy, including their prevalent patterns of interaction with their peers. During the year we shot video of chosen sessions to record teamwork interactions at different times. We reconstitute the recurrent interactions during the experience of learning opportunities in different groups through an ethnographic microanalysis of the events. The events occurred during four sessions of a teaching sequence in which these groups carried out an investigation activity.

The teaching sequence we chose to highlight characteristics identified in the interactions of girls and boys during class is called "activity of variable stars". It has been designed to present physics and raise awareness towards the epistemology of scientific thought, both in history and in personal experience. It takes six classes of fifty minutes at the beginning of the school year. The tasks allow students to experience the process of discovery, searching for evidence to support predictions or exclude the occurrence of a phenomenon, the discipline to carry out measurements, the negotiation of expectations and the organization of a work plan. The purpose is to allow students to simulate the work of a scientific community, including through peer discussion and inter cluster communication.

Such activity has the potential to generate conflicts and tensions that tend to worsen when they revolve around the hegemonic predisposition focused on competition, relations of domination and power struggles. Throughout the study, we identified mixed groups where some girls played important role in the conduct of activities. In these groups we observed cooperation in the tasks even when the boys were subject to hegemonic biases that in the other groups seemed to represent an impediment to collaboration.

The demand of tasks in relation to the collaborative participation promotes negotiations, decisions and actions that can change the settings of masculinity transforming resistance patterns among colleagues in collaborative relationships. In this sense, the participation of girls and the teacher's interventions were crucial in some groups. In the context of this investigation there were evidence that the emancipation of boys and girls of hegemonic masculinity may occur in classroom activities that create opportunities for all students work together on the same level. Thus, power struggles and relations of domination can give rise to settings and practices of gender that promote the full development of students.

Keywords: Learning Opportunities, settings and practices of gender, learning groups, investigation activities, engagement

PS.06.04.d
Strand 6: Secondary School Physics
Parallel Session 06.04
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D402 (3rd Floor)

The radiation education of today in japan

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It is not sufficient to teach radiation for about thirty years on secondary school in Japan. The national curriculum is revised every 10 years (Table1). But the present situation is that majority of science teachers do not have enough experience to teach radiation to the students though the restoration of the radiation education was decided in 2008 and is to be enforced from 2012. In the meantime, the severe accidents at Fukushima Nuclear Plant occurred and plunged the whole nation into fears and disorders. There is not the best way to teach the problem.
There are three difficulties in teaching radiation. Firstly, teachers do not have sufficient specialized knowledge. It is easy to get superficial knowledge on radiation. However, you are able to get only the same level of knowledge with that of the students. They are demanded to explain various phenomenon with nuclear physics theorem in the background. Secondly, it is not obvious what influence is given to humans by exposing radiation. The evasion to assertion by an expert makes people anxious about radiation. Especially, about low-range level of exposing, no one knows existence of the threshold of influence by exposing radiation. ICRP (International Commission on Radiological Protection) adopt the model of linear non-threshold. But there are some opposing arguments. Teachers cannot judge which side to stand for. Thirdly, they will be inquired their view on the fact, policy, or sense of values. It may be hard for science teachers to express their own view. For a long time they have taught students only certain facts, formulas, laws or principles.
The Ministry of Education has edited additional readings on radiation above main textbooks [1]. Some local Boards of Education will require using these readings. They are written very well for general students. But most teachers consider that the readings edited to affirm and promote the nuclear policy of the government without prejudices. For example, the readings have the following description; "It has not determined scientifically that the low exposure of radiation affect human health." The Ministry has obvious intention to deny the influence of the nuclear accident in almost regions. Even if it is the fact, it never relieves the people.
It is little fortunate that some member of teachers and researchers edit the teaching materials voluntarily.

(Table1) Course of Study in High School in Japan ※Subject without Radiation
Year Subject（unit） ratio of study
1956 Physics (3), (5)
1963 Physics A (3), Physics B (5) compulsory
1973 PhysicsⅠ (3), PhysicsⅡ (3) over 80%
1982 ※ScienceⅠ (4), Physics (4) less 40%
1994 PhysicsⅠA(2), PhysicsⅠB (4), PhysicsⅡ(2) less 40%
2003 Comprehensive Science A (2), ※PhysicsⅠ (3), PhysicsⅡ (3) about 15%
2012 Basic Physics (2), Physics (4) ? ? ?

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[1] http://www.mext.go.jp/b_menu/shuppan/sonota/attach/1313004.htm

Keywords: radiation education, national curriculum

PS.06.05.a
Strand 7: University Physics
Parallel Session 06.05
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D403 (3rd Floor)

Temperature dependence of Foucault dissipation studied through video-analysis

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In this work we present an experimental learning path on magnetic induction, aimed to address both Foucault's eddy currents as well as some specific issues on the magnetic field flux through an open surface. Proposed experimental activities are based on the use of a common USB oscilloscope and a commercial grade high-speed video camera. The contemporaneous analysis of recorded video of falling magnets, and of electrical signals induced by them when crossing copper or aluminum rings of variable radius, allows significant didactical insights of the fundamental induction phenomenon. Letting the magnet fall from variable heights, energy dissipation in the rings can be studied for different values of the magnet's crossing speed. On the other side, kinematical measurements performed when the magnet crosses rings of different radius have allowed us to sketch the radial profile (with respect to the fall axis) of the magnetic flux density. Furthermore, all measurements have been performed for different values of the ring's temperature, so highlighting the dependence of the phenomenon on the resistivity of the material. The comparison of these results with previous experimental data, coming from magnets falling through conducting pipes or coils, allows us to draw interesting conclusions on the pattern of Foucault's eddy currents and on the conceptual limits of models of the magnetic field including spatially separated poles or "charges", whenever the magnetic flux concept is involved.
The use of a commercial-grade high speed imaging system, together with video analysis performed by means of the "Tracker" software tool, allowed us to attain a precision in space and time measurements appropriate to implement a quantitative modeling of the magnetic interaction between falling magnet and Foucault currents induced in the crossed rings.
Proposed activities, suitable either for high school students or university freshman, allow teachers to exemplify and quantitatively discuss several topics, ranging from the magnetic flux's variation, to the thermal behavior of Ohmic conductors, and the energetic issues related to eddy currents.

Keywords: learning path, magnetic induction, Foucault's eddy currents, video analysis

PS.06.05.b

Strand 2: Teaching Physics Concepts

Parallel Session 06.05
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D403 (3rd Floor)

A New Way of Teaching the Special Theory of Relativity

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Usually, in introducing in the Special Theory of Relativity we begin by discussing the failure of the MICHELSON-MORLEY experiment. FITZGERALD’s hypothesis, elaborated by LORENTZ stated that all bodies in motion should be shortened in the direction of their velocity. He believed this contraction to be caused by special molecular forces. Very different to this explanation was the assumption made by EINSTEIN: The velocity of light in empty space is the same in all reference frames and is independent of the motion of the emitting body.
This axiom turns NEWTONIAN mechanics into EINSTEIN’s Special Theory of Relativity. Using this axiom, EINSTEIN could prove the very important theorem: The mass of a body and the energy of a body are just different words for the same physical quantity. In the “Karlsruhe Physics Course” EINSTEIN’s axiom and theorem change places. The sentence - mass and energy are the same physical quantity - is now the axiom which changes NEWTONIAN mechanics into EINSTEIN’s Special Theory of Relativity and the sentence – the velocity of light in empty space is the same in all reference frames and is independent of the motion of the emitting body - becomes a theorem. For mathematicians such an exchange is not unusual. One reason for exchanging an axiom with a theorem is that it actually aids comprehension of the problem. It will be shown, that many important results from the Special Theory of Relativity can be developed from the axiom: Mass and energy are the same physical quantity. We get the results by using the computer model-building system “Coach”. This Software was offered by CMA during the GIREP conference in Amsterdam 2006.
When the Special Theory of Relativity is taught in schools, it is not possible to carry out any experiments. The mathematics of Special Theory of Relativity is too complicated.Therefore, computer aided model building provides us with a real alternative. A great advantage of a model-building system “Coach” and others like "Powersim" and "Stella" is that models can be edited by using graphic symbols. We will develop the model “Free falling of a body on the surface of a neutron star”. There are two reasons for this: firstly, the basic model - free falling on the surface of the earth - is easy to understand, thus the model only has to be modified slightly. Secondly, from movies and science fiction, pupils are familiar with neutron stars at least by name. The results of the simulation show us, how the mass of a body depends on his velocity and how energy depends on momentum. The role of light and its speed will appear in an unusual light.

Keywords: Special Theory of Relativity, equivalence of mass and energy, speed of light

PS.06.05.c

Strand 7: University Physics

Parallel Session 06.05

Date & Time: 03.07.2012 / 16:00 - 17:30

Room: D403 (3rd Floor)

Why it is important to publish 'null' results: A project involving no change in learning gains from Interactive Lecture Demonstrations in first year thermal physics

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Interactivity, sometimes called 'active learning', is a popular and effective enhancement to the standard first year physics lecture course (Hake, 1998). Such active learning environments were developed in response to persistent reports of the inefficiency of large lecture courses (Bonwell & Eison, 1991; Prince, 2004). Simply referred to as Interactive Engagement (IE), they span a large number of types with varying levels of 'interactivity' and suited to different environments, however, there is also evidence of varying degrees of success (e.g., Andrews, Leonard, Colgrove, & Kalinowsky, 2011). We report on a null result and discuss its impact on the active learning literature.

Due to the large candidature, the university runs four concurrent streams in first semester, first year physics. We introduced one specific type of IE, known as the Interactive Lecture Demonstration (ILD), to two streams (N1,2=111) of the thermal physics module of the course (Sokoloff & Thornton, 1997). The other two streams (N3,4=92) were given a short exercise to complete in order to collect student identification numbers for learning outcome comparisons. The instruments used to measure learning outcomes were an altered version of the Thermal Concepts Survey (TCS) (Wattanakasiwich, Talaeb, Sharma, & Johnston, In press), the grades for the three thermal physics questions in the final exam, and the final exam mark. T-tests on the four streams show that there were no statistically significant differences in the means of any of these measures. However, the cohort as a whole showed an improvement in the TCS of 0.35 as measured by the construct of normalized change (Marx & Cummings, 2007).

The suggested explanation behind this contradictory result when considering the widespread literature is four-fold: First, we posit that since the program already contains a high level of interactivity (workshop tutorials, demonstrations and practical labs), the introduction of the ILDs did not provide a considerable enough increase to differentiate the four streams. Similarly, the short exercises used in the non-ILD streams could themselves be considered a form of IE since they were contextually rich problems that involved peer instruction techniques. Third, although the cohort was generally homogenous, they were enrolled in different degrees; the two ILD streams were predominantly Bachelor of Engineering students while the others were mainly Bachelor of Science students. This may have affected the interpretation of learning outcomes in a way that was not explored. Lastly, it is possible that ILDs did not improve student marks beyond what is possible with 'traditional' (but still fairly interactive) lecturing.

We affirm that it is important to continue to report studies where there is null result for the purpose of parity and balance in the field. Such results, which are few (Andrews et al., 2011), will help us move forward to deciphering how and why certain techniques are more effective than others and how we can apply these techniques to other contexts. This reporting may also improve the status of the field of Physics Education Research, which is often misunderstood by wider faculty. With data showing research-based techniques are rarely maintained beyond one semester (Dancy & Henderson, 2010; Henderson & Dancy, 2009) and evidence of an over-reliance on positive results on conceptual surveys (Caleon & Subramaniam, 2010), it is difficult to allow other aspects of a program to be emphasised: for example, the overwhelmingly positive student evaluation data and professional development associated with embedding techniques from physics education research.

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Keywords: Active Learning, Interactive lecture demonstrations, Thermal physics, null results

PS.06.05.d

Strand 7: University Physics

Parallel Session 06.05

Date & Time: 03.07.2012 / 16:00 - 17:30

Room: D403 (3rd Floor)

The Application Levels of Physics, Chemistry and Biology Prospective Teachers Zeroth and First Laws of Thermodynamics on Daily Events

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In our universities, thermodynamics course is basically offered in science and engineering departments in addition to biochemistry and pharmaceutics departments as well. The abstract nature of thermodynamics concepts and the link of the course with advanced mathematics makes the teaching of thermodynamics harder (Sichau, 2000). Due to the ambiguity in grasping the difference between heat and temperature students who start to attend thermodynamics classes mostly underline that thermodynamics is a challenging course (Carlton, 2000). Furthermore the tight interconnection between thermodynamics and daily life pose both advantages and disadvantages for trainers (Paik, Cho and Go, 2007). That stems from the fact the pre-knowledge possessed by student may at times facilitate learning whereas this knowledge may occasionally trigger misconceptions (Chi, Slotta and Leeuw, 1994). Aside from that, within the scope of the first law of thermodynamics, the presentation of heat transfer, work and internal energy concepts under the same topic heading and the origination of all concepts from the same basic quality named energy may also push students towards a conceptual ambiguity (Loverude, Kautz, and Heron, 2001).

An analysis on thermodynamics-relevant studies demonstrates that these researches largely focus on misconceptions and teaching of concepts (Harrison, Grayson and Treagust, 1999; Sözbilir, 2002). In addition to the detection of misconceptions and achieving a better training it also bears importance to comprehend the way these concepts are applied on daily events since actual learning can only start when students adapt their learning into different events or explain the daily events with the help of acquired knowledge. The purpose of the present study is to determine the application levels of physics, chemistry and biology prospective teachers, zeroth and first laws of thermodynamics on daily events.

Method

The sample group of the study where the descriptive survey model was employed is composed of 245 prospective teachers who were students in Balıkesir University Necatibey Faculty of Education during 2009-2010 academic year. In sampling selection, one of the purposeful sampling methods namely criterion sampling has been employed. One of the criteria in sampling selection has been whether prospective teachers previously took or were currently taking thermodynamics courses. Research data have been obtained via "Application Test of Thermodynamics Laws on Daily Event" developed by researchers. In data analysis descriptive analysis techniques have been utilized.

Findings and Discussion

In the first question which was concerning the zeroth law of thermodynamics prospective teachers failed to express in a scientific language the way thermometer measured temperature although they knew its function in theory. This finding indicates that the operational principle of thermometer is still a blurred concept in minds despite the widespread use of thermometer in our daily lives and a number of physical activities ranging from primary education to college.

In the remaining five questions related to the first law of thermodynamics prospective teachers have been asked to apply conservation of energy principle on several cases. Prospective teachers faced difficulty in explaining the sample cases though they theoretically knew the conservation of energy. Besides, the first thing that came to the minds of an overwhelming majority of teachers was kinetic and potential energy when they were asked about energy.

A good number of prospective teachers rendered false answers to the question concerning energy conversion in a closed system and cars. This finding indicates that prospective teachers lack sufficient amount of knowledge on the operational principle of a system and/or disregard the fact that a system is never to work 100% efficiently in daily life Tokuya, Yamamoto and Takashi (2004).

Conclusions and Suggestions

Findings of present research manifest that prospective teachers face hardships in applying the laws of thermodynamics on daily events and explaining the sample cases (Tokuya, Yamamoto and Takashi, 2004). It has also been ascertained that prospective teachers possess certain misconceptions and misinformation (Temperature and heat are the same thing. When the temperature of any object rises, there is no energy change. Energy is composed of kinetic and potential energy alone etc.).

Thermodynamics' zeroth and first law that involves heat-temperature and energy conservation principle actually lays the base for all the processes taking place in nature that is why simple explanations for both methods should be provided starting from primary education. While explaining these laws particular care should be paid to establish connections with daily events. By explaining energy conservation from the events that involve energy conversions, it should be aimed so long as possible to conduct processes with the other types of energy other than kinetic and potential energy. The pre-knowledge on thermodynamics that students possess should be identified and the points they fail to comprehend should be detected; by developing new teaching strategies a more effective thermodynamics education should be achieved.

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Keywords: thermodynamics, thermodynamics education, zeroth law of thermodynamics, first law of thermodynamics, heat, temperature, energy

PS.06.06.a

Strand 13: Philosophy, Nature, and Epistemology of Science

Parallel Session 06.06

Date & Time: 03.07.2012 / 16:00 - 17:30

Room: D501 (4th Floor)

Understanding pre-service physics teachers' conceptions on nature of science

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By 1990, the education was awakened by the realization that global growth, demographic changes and technological advances were bringing new challenges to the complexity of human learning. Then, governments begin to reorganize their educational systems to meet the new challenges of the 21st century. As a result, the need for scientifically literate people has been increased in many countries as one of the main goals of science education. Since an important component of scientific literacy, Nature of Science (NOS) concept has been emerged in the educational field. The science educators have strongly recommended by integrating NOS instruction in science courses. Since the year 2000, Turkey has started to reform in curricula putting more emphasis on NOS as a central concept. As well as other disciplines, physics education curriculum renovated in the light of curriculum efforts. Focused on the importance of NOS, new physics curriculum includes the Nature of Physics unit in the 9th and 12th grades. In order to improve science teaching, especially physics teachers' current practices should be changed in a parallel way that is emphasized by reform movements. Teachers' practice largely depends on teachers' adequate knowledge and views about the concept. Therefore, firstly teachers' NOS understandings must be considered so as to effective teaching and learning. Based on these, the aim of this study is to identify pre-service physics teachers' conceptions of NOS. Also the purpose is to investigate how they define the central aspects of NOS. These research questions were investigated as following;

(1) How do pre-service physics teachers understand the nature of science conceptions?

(2) What kinds of views do the pre-service physics teachers hold about the nature of science concepts?

(3) Are there similarities and differences in pre-service physics teachers' conception of the nature of science concepts?

(4) In what ways do pre-service physics teachers experience different aspects of NOS?

As a qualitative research methodology, phenomenology was used. A university in Central Anatolia Region of Turkey was selected as a context of this study. Twenty pre-service physics teachers were participated. Participants were selected from different grades by communicating their adviser. They participated intentionally. Interview method was chosen as a data collection method. As a conclusion, three main themes; sources of pre-service physics teachers' knowledge, NOS views- personal opinions about the NOS and NOS teaching were identified. Most pre-service physics teachers in this study had different experiences about the NOS concepts. In addition, some misconceptions were identified with this study. It is examined to how and in what ways teachers experienced the aspects of NOS understanding. For instance explanation about the theories and laws was one of the difficulties among the pre-service physics teachers. With the help of current study, science teacher education programs may be modified in the direction for focusing and improving the science teachers' understanding on NOS. Besides, it can provide teachers a way of assessing themselves and their students' perception of the NOS in their future professional life.

Keywords: Nature of science, physics education, pre-service physics teachers, teacher education

Physics is cultural arbitrary: An example from historical criticism on Newton's mechanics

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INTRODUCTION
The paper reported in this abstract demonstrates with argument and example that Physics should be considered a cultural arbitrary. The concept of cultural arbitrary is drawn from Bourdieu and Passeron's sociology of education ('La Reproduction'. Minuit, 1970). The historical example that illustrates the status of cultural arbitrary in Physics is drawn from some established critics directed toward Newtonian mechanics ('The mathematical principles of natural philosophy'. Middle temple gate, 1729). In particular, we address the alternative formulation of mechanics initiated by Mach ('The science of mechanics'. Watchmaker, 1919) and further developed by Assis ('Foundations of Physics Letters', 2: 301-318. 1989) which has been called relational mechanics.
RATIONALE
Over the last decades, the development of sociocultural approaches to science education has raised general interest in sociological frameworks. On the other hand, natural scientists often resist acknowledging the relevance of sociology to science education. Hence, this paper advances because it demonstrates (and illustrates with an example drawn from classical mechanics) the importance of sociology in the development of new culturally-grounded views on the nature of Physics.
THEORETICAL FRAMEWORK
The basis of Bourdieu's sociology of education lays on the (often misunderstood) statement that all symbolic systems (such as science, moral, religion, art) are arbitrary cultural constructions insofar as they can never be completely deducted from universal principles (of logical, philosophical, empirical nature). Indeed, the fact that empirical evidence (or theoretical arguments) never justifies a scientific theory is already acknowledged in the 20th century philosophy of science. For example, in Popper ('The logic of scientific discovery'. Routledge, 2002) one will find the idea that scientific knowledge is tentative and can never be proven experimentally. However, Bourdieu goes further on asserting that every educational effort of imposing meanings as legitimate (such as in science education) necessarily follows concealing the arbitrary of these meanings. In other words, it is constitutive of science education the goal (often unconscious) of making scientists' arbitrary statements seem to be necessary and justifiable even when they are not. This rather uncritical way of approaching Physics' most hegemonic theories (from high school to graduate courses) may be acknowledged from the case of Newtonian mechanics.
RESEARCH QUESTION
Considering the general purposes of the paper reported in this abstract, we pose the following research question: How relational mechanics allows us to realize Newton's arbitrary choices that have been systematically concealed in Physics education?
NOTABLE IDEAS
In comparing competing symbolic systems (eg., two different but similar religions), we might apprehend more clearly what, in each of these systems, is arbitrary. On the other hand, a historical feature of science education has been to provide the student only with a single hegemonic theory on each domain. For example, the traditional approach to electrodynamics has been the Maxwell-Lorentz's theory, despite Weber's electrodynamics (Assis, A.K. 'Weber's electrodynamics'. Kluwer, 1994). However, it is precisely in studying Weber's theory that the fundamental inconsistencies of Maxwell-Lorentz's electrodynamics become the most evident. Thus, the core argument of this paper is that by reducing the plurality of theories and interpretations that constitute the historical process of developing scientific knowledge, science educators contribute to concealing the cultural arbitrary status of science.
In Newtonian mechanics, one may observe that the usual definition of inertial frame is rather circular. As Newton states: 'every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon' (1729, p.19). However, any initiated in Newtonian mechanics knows that only a very limited set of reference frames satisfy this law and such are said inertial frames. Herein lays the circularity: the principle of inertia is effectively observed only in inertial frames and inertial frames are, by definition, those for which the principle of inertia holds!

At the abstract level, Newton solves this inherent circularity in postulating absolute space – an intangible frame of reference in relation to which actual (non-relative) motions are to be defined. Despite one may teach Newtonian mechanics without explicit reference to the absolute space (which is clearly a metaphysical concept), the distinction between relative and actual movements is usually not abandoned (for example, when one introduces centrifugal force as a fictitious force arising from the inertial effects of observing mechanical phenomena from an actually moving reference frame). Hence, inspired by the logical positivism, Mach (1919) called for a radical reformulation of mechanics to overcome its metaphysical conceptions. In his understanding, mechanics must assert that kinematically identical movements are dynamically equivalent

and all inertial effects observed experimentally are due to the relation between each body and other ponderable bodies in the universe. This idea is generically referred as the Mach's principle.
Relational mechanics implements Mach's principle and is consistent with more than every empirical data for which Newtonian mechanics holds (Assis, 1989). Hence, its overcoming the conceptual need for absolute space, inertial frames, fictitious forces and actual motion demonstrates that these are unnecessary conceptions that should be contended on consistent grounds.
CONCLUSION
Relational mechanics' empirical consistency brings hard evidence that Newtonian understanding of inertia is arbitrary and demonstrates that Physics itself is cultural arbitrary.
DISCUSSION AND IMPLICATIONS
Despite contemporary authors do not advocate the existence of absolute space; courses on mechanics often rely on ideas such as inertial frames and fictitious forces. Hence, acknowledging the whole Newtonian conception of inertia as arbitrary should lead to new critical perspectives toward teaching mechanics. Finally, providing students with some contact with alternative competing theories (such as relational and Newtonian mechanics) rather than exclusively approaching hegemonic frameworks should be important to: (1) raise some critical perspective toward hegemonic theories through discussing their problems on consistent grounds; (2) develop more culturally-grounded views on the nature of Physics through demonstrating that Physics is cultural arbitrary.

Keywords: Cultural Arbitrary, Bourdieu, Mechanics, Isaac Newton, Ernst Mach

PS.06.06.c

Strand 13: Philosophy, Nature, and Epistemology of Science

Parallel Session 06.06

Date & Time: 03.07.2012 / 16:00 - 17:30

Room: D501 (4th Floor)

A Study on the Epistemological Beliefs of the A-Grade Students and the Local Teachers Surrounding Rajahmundry, India

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Previous qualitative and quantitative researchers showed that expectations, students' and teachers' epistemological beliefs have direct and causal impact on student learning and course grades. Our recent work on the impact of students' epistemological beliefs on their grades of SKR College, India and Woodbury University, USA revealed that better the students' epistemological beliefs better the physics grades. Since most of the students with the poor epistemological beliefs and poor final physics grades were from SKR College, we conducted a study on the epistemological beliefs of the teachers and students of the surrounding area to see if any patterns emerge between the epistemological beliefs of students and teachers.

This study was conducted at Rajahmundry, India. 91 students who scored 90% and above in a state conducted common public exam from about 10 institutions and 109 high school and college teachers from about 90 institutions participated in the study. EBAPS survey was administered to both the students and teachers. The EBAPS survey was translated to the local language Telugu and the administered survey contained English and Telugu versions written side by side.

Statistical analysis indicated several interesting patterns. Histograms of students and teachers scores had similar normal distribution. Results of ANOVA test on teachers' scores indicated that the teachers had higher and significantly different scores on axes 2 (nature of knowing and learning), 3 (real life applicability), 5 (source of ability to learn) from the scores on Axes 1 (structure of knowledge) and 4 (evolving knowledge). Similar ANOVA test on students' scores also gave the same result. For both students and teachers, the spread on axis 4 was twice as much as the spread any other axis, indicating that the evolving knowledge has a high variability. Independent t-tests between the teachers' and students' scores on each axis showed no significant difference on axes 1,2,4, and 5. However the independent t-test showed a significant difference between the teachers' and students' on total epistemological scores and on axis 3.

The mean score (60.589) of the teachers on EBAPS survey were far below the experts scores (90 and above) on the MPEX survey. Teachers' had relatively high scores on axes 3 (71.383) and 5 (70.688), medium on axis 2 (67.07) and low on axis 1 (51.1) and 4 (49.84). Histogram showed higher spread (SD 22.02) on Axis 4 indicating that the variance in scores was more on Axis 4. There was no statistically significant difference between scores on Axes 2, 3, and 5; and on Axes 1 and 4.

The mean score of students was 57.098 on EBAPS survey. Students' also had relatively high scores on Axes 2 (64.87) and 5 (67.75), medium on Axis 3 (55.39) and low on Axes 1(47.72) and 4 (48.26). Histogram showed high spread (SD 21.71) on Axis 4 even for students. There was no statistically significant difference between the Axes 2 and 5; and 1 and 4. Independent t-tests showed a significant difference between the male and female students. On EBAPS survey, the male students' mean score (59.39) was higher than the female students' score (55.13). On Axis 1, the male students' mean score (50.60) was higher than the female students' score (45.30). However there was no significant difference between the male and female scores on the other axes.

Even though the students had physics for a total of five years in high school (three years), and in intermediate (two years) colleges, and had scored 90% and above in the common intermediate exam the beliefs were poor. Possible reasons could be that the students probably hardly had time to reflect upon due to the instructional methods followed in the institutions; the school and college education in this area require the teachers to complete the syllabus at the cost of students' understanding; focus more on repetition and memorization than reflecting upon; and focus the instruction to pass the common final examinations that emphasizes on writing definitions and deriving equations. The data on the teachers' beliefs revealed that the teachers in this area may have poor epistemological beliefs. These teachers were also the product of the same educational system. It was interesting to see that the male students had better epistemological beliefs than the female students.

In view of this study we recommend further investigations to see if the students' epistemological beliefs are related to the teachers' epistemological beliefs and if there is gender difference in the beliefs. We recommend that the local educational authority should conduct workshops for in-service teachers on the epistemological beliefs and instructional methods, change the examination system that elicit students' holistic knowledge and emphasize on reasoning, conduct bridge courses, and restructure the high school and college syllabus to integrated syllabus.

Keywords: Epistemological beliefs, Teachers, Students, Structure of the knowledge, Nature of knowing and learning, Applicability of the knowledge, evolving knowledge, source of ability to learn.

PS.06.06.d

Strand 13: Philosophy, Nature, and Epistemology of Science

Parallel Session 06.06

Date & Time: 03.07.2012 / 16:00 - 17:30

Room: D501 (4th Floor)

Physics Students' Epistemological Beliefs and Their Conceptual Change

Feral Ogan Bekiroglu, Ercan Kaymak

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Introduction

Research indicates that students' epistemological beliefs may either enhance or constrain the scope and nature of the motivational beliefs, learning strategies, and knowledge that are accessible to the learner as well as the nature and quality of various learning outcomes (Paulsen & Wells, 1998). Therefore, students' epistemological beliefs have come into prominence. The purposes of this study were to determine physics students' general epistemological beliefs and to explore any relationship between their beliefs and their conceptual change in physics.

Theoretical Framework

Theoretical framework of this study is based on the conceptual change model developed by Posner, Strike, Hewson, and Gertzog (1982). According to this model, personal epistemological beliefs, namely, beliefs about the nature of knowledge and acquisition of knowledge were considered as playing an important role in learning.

Literature Review

Epistemological beliefs may act as resources facilitating conceptual change and guide students to intentionally pursue the goal of knowledge revision (Mason, 2002). They can influence both the kinds of new information that is picked up from the physical and sociocultural context and the way in which this information is interpreted (Stathopoulou & Vosniadou, 2007). Consequently, the research on epistemological beliefs helps us understand how individuals resolve competing knowledge claims, evaluate new information, and make fundamental decisions that affect their lives and the lives of others (Hofer, 2001). In recognition of the presuppositions mentioned above, it is important for teachers and educators to identify students' epistemological beliefs and to examine their link with learning.

Methodology

Correlational study design with quantitative methods was guided to the research. The research was conducted with tenth-grade physics students studying in an urban school. The students' general epistemological beliefs were determined by using Schommer's Epistemological Beliefs Inventory (EBI) that she developed in 1990. This inventory consisted of 63 items with five-Likert-type scale distributed under the following four dimensions: simple knowledge, certain knowledge, innate ability and quick learning. Assessment Instrument for the Concepts of Work, Power, and Energy (AIWPE) was developed to assess students' conceptual change. The concepts of work, energy and power exist in the elementary science curriculum. Therefore, the students had prior knowledge of these concepts. The AIWPE consisted of 13 open-ended questions measuring conceptual and procedural knowledge. The authors ensured content validity of the instrument and face validity of the questions by working with the experts.

The participants were answered to the EBI in the beginning of the research. Next week, their knowledge of work, power and energy concepts was assessed in the pre-test before the instruction started. The instruction lasted six weeks. They gave their responses to the questions in the AIWPE one more time in the post-test in order to determine their conceptual change. Each application lasted one lesson hour.

Data for the participants' epistemological beliefs were analyzed quantitatively. The students' epistemological beliefs were categorized as low (1.0 – 2.0), medium (2.01 – 3.0), high (3.01 – 4.0), and very high (4.01 – 5.0) for each dimension because beliefs are held in clusters. Data for the participants' conceptual change were analyzed qualitatively. The students' knowledge for each question was categorized as compatible elaborate, compatible sketchy, compatible-incompatible incompatible sketchy, incompatible elaborate, and no response based on the bidemensional coding offered by Hogan and Fisherkeller (1996). Inter-rater reliability value was calculated as 93% for the knowledge categorization. Comparison of epistemological beliefs and conceptual change was made by calculating Pearson product-moment correlation coefficients.

Results and Discussion

According to the findings, while 83% of the students had high-level epistemological beliefs, only 11% of them held medium-level beliefs. In the dimension of innate ability, 12% of the students had very-high-level beliefs whereas 88% of them had high-level beliefs. Regarding the simplicity of knowledge dimension, on the other hand, more than a half of the students' (56%) held medium-level epistemological beliefs and 44% of them were able to reach high-level in terms of their beliefs. With regards to the quick learning dimension, again 12% of the students had very-high-level beliefs while 88% of them had high-level beliefs. There was diversity in the certainty of knowledge dimension. Put differently, 5% of the students had low-level beliefs, a half of the students had medium-level beliefs, and 33% of them held high-level beliefs. Results show that most of the students' epistemological belief level was high. This result is compatible with Yang's (2005) finding that most students were multiplist.

Findings demonstrate that the students had quite sophisticated beliefs in the dimensions of innate ability and quick learning. That is, the students believed that success did not require innate ability and learning was a gradual enterprise and did not occur quickly. However, almost a half of the students held less sophisticated

epistemological beliefs in the dimensions of simple knowledge and certain knowledge. These students did not believe that knowledge was composed of interrelated concepts and could change over time.
Findings also present that while 17% of the students did not change their knowledge, 66% of the students raised their knowledge to compatible sketchy level and 17% of them were able to reached compatible elaborate level. In other words, conceptual change process occurred and almost all of the students somehow repaired their misconceptions. Considering that 83% of the students had high-level epistemological beliefs and 83% of the students had conceptual change, it can be stated that when students had sophisticated epistemological beliefs, they could learn scientific concepts.
However, there was not any correlation between any of the dimensions of epistemological beliefs and conceptual change based on the statistical results.
Conclusions and Implications
The following conclusions can be drawn from the study. First, physics students' general epistemological beliefs are very close to sophistication. Second, students have more sophisticated epistemological beliefs about the acquisition of knowledge while they have less sophisticated beliefs about the nature of knowledge. Third, there is no relationship between students' general epistemological beliefs and their conceptual change in physics.
This study would contribute to the literature toward a better understanding of high school students' epistemological beliefs and has implication of presenting non-existence relationship between beliefs and learning.

Keywords: high school physics students, epistemological beliefs, conceptual change

PS.06.07.W

Strand 2: Teaching Physics Concepts

Parallel Session 06.07 Workshop
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D502 (4th Floor)

An Alternative Way to Teach "Oscillation and Waves"

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The traditional way to teach the topic "Oscillation and Waves" starts with a treatment of the harmonic oscillator and its mathematical description on the base of trigonometric functions. The same procedure continues after installing a system of coupled oscillators and the introduction of waves, leading finally to the solution of the wave equation in form of a time and position depending sine-function.
The dominance of sine waves when treating transmission processes has different reasons. Sine-waves are easy to produce, they are found in many natural phenomena and their mathematical description is simple and quite elegant, especially if it is expended to Fourier analysis.
This method has some didactical drawbacks which can best be discussed in the light of alternative approaches.
Such an alternative approach in form of a tutorial has been developed, on which the workshop will be focused. This approach reverses the traditional sequence by starting with the transmission of pulses as a basic process, and finally leading to the transmission of sine-waves as a special kind of repetitive pulses.
In this tutorial an intensive use is made of a simulation program, named TL (Transmission Line), where the transmission line equations are solved by means of a new numerical technique, using Finite Differences in Time Domain (FDTD), adapted to deal with dispersive and non-homogeneous lines. The developed algorithm solves the transmission line equations with the boundary conditions imposed by the source and load or any change in the transmission line parameters.
Based on the assumption that mechanical systems are easier for newcomers to conceptualize than electrical ones, the topics like transmission, reflection and superposition are first applied and visualized to transmission processes within mechanical system like linear and circular tubes.
In a second part the same topics are repeated and applied to the electrical case of transmission processes on a double line, demonstrating the similarities and differences between these two systems. At this point a mathematical description shows up for the first time, when the impedance of the line and its dependence of L and C is introduced.
The assumption and hope is that the invested extra time for studying the mechanical systems will pay off as added value in respect to deeper understanding, increased interest in topics of physics and technology and higher motivation for continuous learning.
After getting acquainted with this new approach and the implemented simulation program the focus during the workshop will be directed to a reflection on some drawbacks when using the traditional approach, the proclaimed added value of this new approach and the question, how to organize the transfer to the mathematical description of transmission processes in frequency domain.

Keywords: Waves, harmonic, transient, transmission line

PS.06.08.W

Strand 9: Teacher Professional Development

Parallel Session 06.08 Workshop
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D504 (4th Floor)

Getting Practical in the Netherlands

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Practical work is essential in secondary school science education. Although there is no doubt about that statement, for example in the Netherlands, there is a discussion going on about the efficiency of practical work: what do students learn when they work on practicals, and is this the most efficient way to do so? (SCORE, 2008).

In order to motivate an on-going implementation of practical work, it is important to make clear the specific goals of practical work. This of course can be the development of specific subject knowledge and concepts, but also practical skills, more complicated skills like research and design, or motivation (Hodson, 1996; Abell & Lederman, 2007).

In the UK, the last years, a new initiative has been worked out which focuses on the goals and implementation of practical work under the title Getting Practical (2009). In every Getting Practical training, teachers discuss goals and working out of their own practicals. Based on the results of this discussion, teachers improve practicals collaboratively and design new material with clearly formulated goals. In this way, teachers get clarity about the learning outcomes as associated with practical work, and pupils experience more effective practical work which has more impact on what is learned in science lessons in total.

The introduction of Getting Practical in GB also reached the Netherlands. In the Netherlands GP is introduced by implementing it in teacher development teams. One of the results is the detailed development of different learning progressions for practical skills within the subject electricity. According to the needs of the students the sets of practicals can differentiate within one chapter on the learning goal.

We want to fill this conference session partly with an interactive discussion about deliveries of practical work and in this way we give a first impression of the project Getting Practical. Secondly we will discuss first experiences and products from a Dutch design team of teachers from the university of Twente. First research will be discussed from the Delft University of Technology who compared the learning outcomes of practicals designed by the Getting Pracical way to regular practicals.

Abell, S.K., & Lederman, N.G. (2007). Handbook of research on science education. Mahwah, NJ: Lawrence Erlbaum.

Getting Practical (2009) (http://www.gettingpractical.org.uk/ (working link: 16 Feb 2012)

Hodson, D. (1996). Practical work in school science: exploring some directions for change. Int. J. Sci. Educ., 18(7), 755-760.

SCORE (2008) http://www.score-education.org/downloads/practical_work/report.pdf (working link: 16 Feb 2012)

Keywords: Pratical Work, Inquiry Based Learning, Continuing Professional Development, Teacher Design Teams

Liquid cyrstals in school - what can they offer?

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Today, developed countries are confronted by a decreasing interest in the science and technological studies. One possible reason is a detachment of topics taught in school from the everyday life. Most of the science topics taught were discovered more than hundred years ago, topics are old from the students' perspective and they do not relate to anything in a real life [1]. Another problem is that teaching of natural sciences is often too traditional [2] which suppresses the excitement that science can so readily offer.
Liquid crystals have attracted physicist from the beginning of the 20th century. 35 years ago many properties of liquid crystals still seemed to be mysterious oddities, while today they are successfully used in displays and other applications. What is more, they are willingly taken as starting points, reference systems and physical models for scientists working in such different fields as anisotropic superfluids, surfactants or even cosmology [3]. Liquid crystals are a modern material, which are used every day in several devices. They are a constituent part of the flat screens, mobile phones, touch-screen devices and similar. As such, they are a modern topic, which supports relevance of physics for everyday life. Even more, the topic is a part of an intensive academic research and an on-going development of new technological devices is very important for technological advances. As such, liquid crystals are a topic, which can seriously increase motivation for physics if properly introduced into the classroom.
Having in mind all mentioned above, we designed a set of hands-on experiments based on liquid crystals, which could be synthesized in the school laboratory, and show all the basic properties of liquid crystals. The first part of the experimental set presents the liquid crystalline state as a special state of matter and how the temperature dependent properties can be observed and used for determination of phase transitions. Next, the participants of the workshop will construct three cells – the cell with disordered liquid crystals, the cell with oriented liquid crystal and the wedge cell, which allows for more detailed studies of their optical properties. Experiments with liquid crystals will be accompanied with the set of experiments that serve as models of liquid crystalline structures and their properties. We will show structures of liquid crystalline phases (nematic, smectic, cholesteric) made of wood and how the structure influences the microwaves in the same way as it affects optics of liquid crystals. We will show the mechanical analogue of the first and the second order phase transitions, as both types of phase transitions appear in liquid crystals. Finally we will show the experimental sequence for studying anisotropic optical properties of everyday materials like tapes or food wrappers and how they are related to the complexity of the conoscopic image used in academic research of liquid crystals.
The set experiments is adapted to teachers use, accompanying explanations are adapted to the students cognitive level from lower secondary level to the university level for students of physics.

[1] J. Osborne, S. Simon, and S. Collins, Int. J. Sci. Ed. 25, 1049-1079 (2003).
[2] A. Sorgo, and A. Kamensek. Energy education science and technology. Part B, Social and educational studies, 4 (2), 1067-1076 (2012).
[3] O. D. Lavrentovich, Book Review: The physics of liquid crystals. Liq. Cryst. today 4, 7 (1994).

Keywords: modern topic, liquid crystals, simple experiments

PS.06.10.a

Strand 2: Teaching Physics Concepts

Parallel Session 06.10
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D506 (4th Floor)

Gravity as a Conservative Force: A Survey of Misconceptions

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One of the cornerstones of Physics is the Law of Conservation of Energy. This concept and its consequences are taught to freshmen non-science students as part of a natural science course. While a significant amount of class hours is devoted to lessons on free fall and universal gravitation, gravity as a conservative force is often left as a reading assignment or left out altogether. Various studies on students' misconceptions of gravity have already been performed, but most of them deal with its application to motion and weightlessness.
This paper surveys freshmen non-science students' various ideas and misconceptions on gravity as a conservative force and its consequences. Furthermore, this paper explores whether wrong or incomplete understanding of conservative forces affect students' overall grasp of the concept of Conservation of Energy. The concept was established using classroom discussions on potential energy as a function only of relative positions. Path-independence was illustrated as gravity doing the same amount of work on an object regardless of the distance travelled, as long as the endpoints are the same.
Assessment of students' understanding of conservative forces and energy conservation is made in the form of two sequential open-ended essay questions in a long exam: (a.) The work done by a conservative force on an object in going between two points is independent of the path taken by the object. Is gravity a conservative force? Cite concrete examples to justify your answer; and (b.) If a height of a playground slide is kept constant, will the length of the slide or presence of bumps affect the final speed of children playing on it (assuming it is frictionless)? What if there is friction? Why?
Answers to these questions are counted and grouped according to their frequency of occurrence. Upon analysis of results, it is discovered that only 7.46% of the population are able to perfectly explain gravity as a conservative force and cite examples. On the other hand, 52.2% of the population are able to perfectly explain the concept of energy conservation without necessarily learning what conservative forces are all about. Finally, 100% of students who correctly explain conservative forces continue to explain energy conservation perfectly.

Keywords: Gravity, Conservative Forces, Misconceptions

PS.06.10.b

Strand 2: Teaching Physics Concepts

Parallel Session 06.10

Date & Time: 03.07.2012 / 16:00 - 17:30

Room: D506 (4th Floor)

Development and Administration of Concept Survey on Wave Particle Duality and Uncertainty Principle for Undergraduate Students: A Pilot Study

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Effective teaching encompasses knowledge of what prior beliefs learners bring to the classrooms and evaluating how these beliefs change during or after instruction. Researchers have designed and developed a number of conceptual surveys/inventories covering different physics domains such as Force Concept Inventory to gauge student prior knowledge and assess learning. Solid state physics is the largest branch of condensed matter physics which deals with the study of the structure properties of solids and the relationship between the phenomenon of solids and physical principles behind them. Quantum mechanics is the key to understand the fundamental properties of matter, which is a collection of large number of microscopic particles (10^23), their spectra and chemical behavior. It fundamentally describes the behavior of particles at the atomic level and states that matter and energy have the properties of both particles and waves. Therefore, we find that a good conceptual understanding of themes of wave particle duality and uncertainty principle is very essential for the learners, before they go ahead with the learning of a solid state physics course. In fact wave nature of photons and electrons laid the foundation of solid state physics through classical Laue diffraction and Davison and Germer diffraction by crystals. This paper describes a preliminary study of developing an assessment tool to gauge the student’s prior knowledge and depth of understanding of these two themes, which is a prerequisite for understanding the course on solid state physics at undergraduate level i.e. Bachelor of Science (B.Sc.) three years course. In this paper we discuss the main steps involved in the development of the seventeen- items (version 1.0) of the survey including validation and reliability and preliminary results of gains (pretest to posttest) administered on students in four colleges and a sample of teachers attending a refresher course in physics as well. The percent score of the students on most of the items lies below the 60% conceptual threshold inferring that they will have poor problem solving capabilities.

Keywords: quantum mechanics concept survey, reliability, validity

PS.06.10.c

Strand 2: Teaching Physics Concepts

Parallel Session 06.10

Date & Time: 03.07.2012 / 16:00 - 17:30

Room: D506 (4th Floor)

On the teaching of the concept of Time Evolution on Quantum Mechanics

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[2]Physics Institute, Federal University of Rio Grande do Sul, Porto Alegre, Brazil

Non Relativistic Quantum Mechanics Teaching constitutes a research topic that has acquired relevance in Physics Teaching. Inquiry on structural concepts that facilitate meaningful learning in this area of knowledge is quite important, taking into account the learning difficulties that are greater in this field than in the ones associated with Classical Physics. We designed a didatic approach based on Ausubel's Meaningful Learning Theory and Vergnaud's Conceptual Fields Theory in order to facilitate the Meaningful Learning of the concepts of physical system, dynamical variables, state of a physical system and time evolution. These concepts were selected by their structural position in Physics and by the diferentiations, some subtle and others not in the comparison between Classical Physics and Non-Relativistic Quantum Mechanics. The assimilation patterns in the predicative form of knowledge were studied, as well as the use of operatory invariants (concepts-in-action and theorems-in-action) in the mastering of situations proposed in an instruction with average duration of 12 hours inside class (besides the period of problem solving consumed by the students that occurred outside class).Three groups (two of them composed by six students and the other of five) were studied. The instruction had six expositive-dialogued lectures in which meaning negotiation between teacher and learners was stimulated by problem-situations or by conceptual manipulation. Most of the students shown vague concepts in the pre-test that seemed to be changed during the Instruction. There are evidences that some of these concepts changed into quite accurately forms, others partially modifed and some few concepts, because of misunderstanding or lack of instructional reinforcement, seemed to change into epistemological obstacles. There are some indications that the concepts of physical system and dynamical variables have been mastered quite well, taking into account the more general essential attributes of these concepts; while the first seemed to be accepted in Classical and Quantum situations, the second shows some diferentatiations that most of times gave evidence of being well assimilated by the very great part of the students. The concept of quantum state, for including new features, was acquired with a higher level of difculty and, besides that, it seemed to be subsumed as a diferentiation of the one of dynamical variable. There are some evidences indicating the assimilation of the concept of state superposition under the one of probabilities instead of the one of probability amplitude, what led much students to understand quantum principles as related to an incomplete information or to impossibility of determination of quantum states. Despite this confusion associated to this specific feature of the concept of state superposition, it seemed to be mastered by most of the students in the operatory form. We mention as a positive aspect the modification of the concept of time evolution during the instruction, in spite of showing a strong association to the concept of physical system, which turned out to be an element, or variable, we had not anticipated at the beginning of this research. Moreover the concept of time evolution seemed to be attached to the one of causality which seemed to assume a stable form, however, some of the students shown some evidence of relation between this concept and the wrong idea of lack of predictability of quantum states. The last finding led them to believe that determination of the quantum state is only possible if it's an eigenstate of the operator attached to the dynamical variable that is being measured. The analysis of the answers to the problems and, in some sense, to the enterview (made with one of the groups) shown evidence of using of operatory invariants, this means students' beliefs in relatively steady propositions considered true about reality.

Keywords: Physics Teaching, Quantum Mechanics, Meaningful learning

PS.06.10.d

Strand 2: Teaching Physics Concepts

Parallel Session 06.10
Date & Time: 03.07.2012 / 16:00 - 17:30
Room: D506 (4th Floor)

Development of a TLS on the relativity of time and the Twin Paradox: Analysis of its Structural Elements

Mauricio Pietrocola[1], Ivã Gurgel[2], Jorge Nicolau[1], Graciella Watanabe[2], Armando Tagiku[1], Itamar Santos[1], Helio Vicentini[1], Leandro Oliveira[1], Fabio Beig[2], Maria Beatriz Fagundes[3], Alexandre Bagdonas Henrique[2]
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A lot of projects to upgrade science teaching in recent years has generated the need for research dedicated to understanding the processes involved in curricular innovations. This need arises from the fact that educational changes are difficult to implement. The construction of an innovative teaching-learning sequence (TLS), that is, that breaks with established educational standards, involves a series of negotiations aimed to fit with classroom commitments. Among the main problems present in the construction of a TLS one points: accuracy in relation to scientific knowledge (original epistemological context) x appropriateness of the objectives to students needs of education (knowledge application in students' contexts), and historical time of knowledge x available time of teaching; students' autonomy of choice x educational content determined by curriculum, etc.. One way to address the curricular innovations and analyze the process in a research perspective is by case studies in a small and medium time scale. His goal focuses on the way to design, implement and evaluate teaching and learning sequences of one specific scientific topic. An important feature of this line of study is to address both research and development of teaching activities (Méheut and Psillos, 2004). These reasearche can be understood as: "a study involving the design, development and application of teaching sequences on a specific topic" (Méheut and Psillos, 2004). During the second half of 2011, a group of researchers, graduate students in physics education and secondary school physics teachers developed a TLS on the topic "relativity of time and twin paradox", dedicated to the high school level students. During this period we performed the first cycle of design, implementation and evaluation. In this paper we present the design process of the TLS produced. Through qualitative analysis of the group, which were recorded on audio and video, we have analyzed the process of pedagogical negotiation inside the group and advanced some outcome in terms of structural elements of TLS, i.e., a set of definitions and options assumed by the group for the first version of the TLS mentioned above.
The following features are the result of the analysis: 1 - Educational Rational for the theme choose: based on the research results, official standards and the epistemological relevance 2 - didactic and epistemological assumptions, are defined the concepts of knowledge and learning adopted in relation to the subject, 3 - Obstacles epistemological and didactic: they revealed the obstacles inherent to acts of knowing and teaching that hinder the development of TLS, 4 - Learning objectives, which are indicated parameters are considered relevant for student learning; 5 - Course designed teaching: teaching situations indicated is needed to meet the learning objectives.
In a summary way, the above analysis allowed to produce two representations of the TLS: a structural representation, which indicates the elements that constitute and justify, and representation of the course textbook uam that indicates the sequence of teaching and learning activities:
Structure of the TLS
1-General Objectives and Rationale: Why teach Relativity?
2 -Epistemological Assumptions and Educational.
3-Obstacles: Epistemological, cultural, social and / or didactic-pedagogical.
4-Specific Objectives.

Keywords: theory of relativity, TLS, Secondary school,

JULY 4, 2012
WEDNESDAY

PS.07.01.a
Strand 2: Teaching Physics Concepts
Parallel Session 07.01
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D506 (4th Floor)

Teachers' Actions in the Collaborative Construction of Arguments

Lucia Helena Sasseron, Anna Maria Pessoa De Carvalho
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Studies related to the construction of arguments in the classroom are an integral part of data analysis methodologies in studies on science teaching and learning (Erduran, 2007). Such studies are gaining strength and focusing, especially, students' argumentation in regard to quality of the argument constructed as well as to the argument's structure (Erduran & Jiménez-Aleixandre, 2007, Driver et al, 2000, Jiménez-Aleixandre et al, 2000). Previous studies show that teachers' role in creating and encouraging dialogical practices in the classroom is essential to promotion of argumentation. Thus, we intend to identify actions carried out by teachers that contribute to the occurrence of dialogical practices in the classroom and how they can be helpful in the process of constructing arguments.

Objective

Based on analysis of the transcriptions of verbal discussions that took place during the implementation of an inquiry-based teaching sequence, we intend to identify how teachers can help in the construction of arguments by means of teacher-student discursive interactions. Our objective in this proposal is to study the following question: What teacher actions in the classroom can help students to organize their ideas and construct explanations?

Methods

Our corpus comprises transcriptions of verbal interactions that took place in classroom situations. Our data were collected in a 4th-grade elementary school class made up of thirty 9-10-year-old students. In these classes, it was apply a sequence teaching featured discussion ranging from conditions for the floating of bodies, to the point where it was possible to discuss the misuse of water as ballast for ships and environmental problems stemming from such misuse. We selected two classes for the findings in this proposal.

Results

Taking into account the teacher's actions in the course of the discursive interactions, we can see that her utterances are characterized, above all, by statements that lend positive support to the students' comments, as well as short questions aimed at the two main objectives**:** the recovery of information previously debated and the construction of relations among the variables investigated. To attain such objectives, the teacher is careful to ask a question so that the students can mention evidence associated to the phenomenon being investigated. Another of the teacher's actions that calls attention is her care in systematizing students' ideas. In her statements, the teacher uses ideas mentioned by the students, thus ensuring that the whole class is aware of which facts are important. At the same time, in these situations, one notes that the teacher emphasizes the proper names of categories and/or relationships, clear evidence of her concern to transpose the students' use of common everyday terms into scientific language (Lemke, 1997).

Based on our analysis, we were able to confirm that the teacher's actions followed a certain model and allowed for the construction of arguments by means of dialogical teacher-student interactions. Starting with the retrieval of previously discussed information and organization of the existing data, followed by the organization of this information so that relevant variables for the phenomenon in question could be identified. At this point, the explanations became more explicit and justifications were brought to support them.

Implications

Findings point out to existence of an argumentation cycle. This cycle involves dissemination of the construction of understanding of a concept or topic by means of dialogical practices established between teacher and students. In our opinion, this argumentation cycle is the means by which argumentation develops and the manner in which the relationships among different data and variables are established.

We perceived that the first step was care with the data. Once in possession of data, it was necessary to organize it conveniently. After the work with the data/information came the moment in which variables for the problem began to be defined. Here we noted that the first hypotheses began to be mentioned. At the same time, justifications were associated to the statements made and predictions as to what could happen should the idea stand up also appeared. The justifications and predictions play the interesting role of demonstrating certainties and contrasts, and thereby make space for the relevant and meaningful information in that given investigation and its connections to the others. The explanations themselves completed the argumentation cycle. At this point, all of the previously made constructions were used to establish connections between the information and the variables, and thus a more concrete idea was presented of how the effects seen or predicted actually occur.

The importance of these statements resides in: by studying how arguments are constructed in the classroom and perceiving the cycle by means of which an argument becomes increasingly complete, we will be able to find foundations on which it will be possible to consider how a discussion can be developed and guided by teachers in classrooms. This is not a case of merely leading teachers to be aware of the need of argumentation for students to be able to construct meanings; it also involves enabling teachers to recognize the need for taking subsequent steps during discussions and thus working to encourage the appearance of those meanings.

Keywords: Argumentation, Elementary School, Teachers' actions

New perspective on rotations: experiments, modelling and analogies based on angular momentum as an extensive quantity

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Research in the educational field points out widespread learning problems in mechanics. We propose here an approach based on a conceptual revision explaining how our usual perception of reality is grounded on image schemes which are common among different aspects of human experience [1].
The description of processes in mechanics usually starts from kinematics, although this way the concepts and the mathematical instruments perceived as abstract entities by the students. Our approach is based on extensive mechanics quantities like momentum and angular momentum. In particular, besides being a solid base for algebraic development, the balance equations are capable to develop clear mental images of the processes.
This contribution highlights the advantages of such an approach with two examples of didactic experiences coming from different contexts: the informal one of a science centre and the formal one of a school laboratory.
Coherently with the approach, we make use of analogy as the theoretical element and on-line data acquisition combined with dynamical modeling as the technological one.
As an example, the problem of angular momentum conservation and its transfer between different systems is considered. Firstly, we propose the experience with "Angular Momentum Carousel", placed in the Didactical Laboratory "Fisica in Moto" of Ducati. The workstation allows for a change in the inertia of the system while it is rotating and gives the possibility to investigate the time evolution of angular momentum depending on the mass distribution.
Secondly, it is shown a device built in the didactical laboratory of 'Liceo Cantonale' in Locarno. This experiment investigates the interaction between two metallic paired coaxial flywheels, one of them initially rotating and the other exchanging rotation by means of magnets.
The dynamical modelling gives the possibility to discuss the two phenomena in relation with the initial conditions and the parameter values. Moreover, the introduction of analogies allows to develop and to strengthen basic concepts, as well as to easily apply them in a wide range of contexts.

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Keywords: angular momentum, conservation, experiments, dynamical modeling, analogy

PS.07.01.c

Strand 2: Teaching Physics Concepts

Parallel Session 07.01
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D506 (4th Floor)

Discourse and Argumentation in an Urban Science Classroom

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Many students come to science classes with preconceptions of the types of energy that are present in their everyday worlds and their transformations. Their opinions are silenced as they learn to accommodate school terminologies and replace them with that of their everyday experiences (Davis, 2001). Recent developments in the concepts of "science -for-all" curricula have focused on how students move between their everyday lives and the world of school science (Aikenhead & Jegede, 1999). Minstrell (2001) describes these as facets of student thinking. Facets explain why conceptual exchange is truly challenging for our students. Conceptual exchange involves a dual process of raising students' scientific conceptions and lowering their preconceptions. Some common misconceptions of the types of energy and their transformations are: Energy is categorical: Energy is either one kind or another (e.g. all kinetic or all potential; objects either have energy or need energy; and energy is truly lost in many energy transformations (Diagnoser, 2011). The conventional forms of teaching energy (i.e. lecturing, handouts, worksheets, cookie-cutter labs, etc.) will only lead to the assimilation of the scientific views within their current preconceptions. Science education researchers believe that having students engage in academic and social discourse and argumentation allows for these preconceptions to be addressed in a safe environment (Erduran, Simon, & Osborne, 2004). Students in urban populations often have difficulty expressing their beliefs with the accepted "science" language. Furthermore, the literature on conceptual change does not address its implication for urban and minority areas (Buxton, 2006). The use of academic discourse and argumentation could be used to introduce students to the formalities of argumentation patterns allows, which would allow for richer and sound dialogue between peers and ultimately lead to conceptual changes. Additionally, this study gave students a chance to talk out their frustrations with the concept in a friendly, student centered, and open environment. In this study, urban minority students' discourse and argumentation patterns were explored and examined to increase conceptual awareness and change preconceptions, using a teacher created card game (like UNO). Students were given several cards with pictures and energy terms (such as nuclear, electrical, thermal, etc.) and were not allowed to release their cards, until they had made successful energy transformations sets. Students were introduced to the energy concepts beforehand and were allowed an opportunity, in this study, to explore opposing views about their peers' transformations. The case study method was used to explore and examine urban minority student discourse and argumentation patterns (Yin, 2008). There were twenty-two students enrolled in this honors/advanced level Physical Science course, in a large metropolitan school district in Southeastern United State. Twenty-one students participated in the study and one student opted to be removed from the study, because the student did not want to be audio or video-taped. The findings show that students experienced an enormous conceptual shift in their ways of thinking of energy transformation and scored higher on their culminating unit exam, versus students who were taught using the traditional teacher practices. Previously, students had been asked to be bystanders in the production of scientific knowledge. Having been involved in this conceptual change activity, students became co-creators of knowledge as they discussed and validated the reasons of how they believed energy transformed from one form to another (Hewson & Hennessey, 1992). From this study, it is possible to deduce that introducing minority students or students who lack appropriate "science language" knowledge, to nontraditional forms of teaching in physics, such as the use of discourse and argumentation via a card game can increase student motivation, student confidence, and academic success.

Keywords: Discourse, Argumentation, Urban Classroom, Energy Transformations

PS.07.01.d

Strand 2: Teaching Physics Concepts

Parallel Session 07.01
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D506 (4th Floor)

Understanding and modelling in physics - the circular motion revisited

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Physics requires by its nature the abstract processes of idealization and modelling. This characteristic has great impact for teaching physics. Often the physics educators make - out of their experience - tacit assumptions that are not always made explicit to the learner. Furthermore the learners rely on their previous experience in interpreting and understanding the physical processes themselves as well as the modelling presented by the educator.
The method of "multiperspective modelling" considers all relevant modelling perspectives in a problem and all the necessary steps in the process of modelling are made explicit. One example of its application is the understanding of the mirror image where the apparent situation of the image differs from the intuitive perception. The teaching incorporates explicitly the human, the physical and the mathematical perspective. Herewith very good learning effects of the multiperspective modelling could be shown in a study with beginning physics learners of age 11 to 12 years, (Böhm 2012).
The aim of this proposal is to show that this method can be applied successfully to constructing the teaching and learning of complex content. Hence we choose an example for an integrated modelling on basis of multiperspective modelling, used frequently in secondary education: the circular motion. Here generally substantial misunderstandings are being found at high school and at university. To reach a stable and deep understanding the multiperspective modelling includes the physical perspective, the mathematical perspective and the subjective experiences of students. In addition it is informed by the historical perspective revealing that the crucial step in understanding circular motion was abandoning the concept of a "centrifugal" force.
The physical perspective analyses: Which physical forces are acting?, the mathematical perspective derives the formula for centripetal acceleration of uniform circular motion from geometry, taking into account as physical basis the centripetal force, the "human" perspective makes the students aware of their experiences: What am I sensing and which forces do I "use" when sitting e.g. in the carousel?
Understanding circular motion presupposes that the student clearly distinguishes all these perspectives of modelling and can set them into relation to each other. A central point in connecting the physical and mathematical perspectives is the correct interpretation of the equation $F=mv^2/r$. The equals sign could be interpreted as meaning equilibrium or as assigning the acting forces to the general expression of the centripetal force. Both interpretations transport different physical meaning hence may not be confounded. This aspect is connected to Sherin's "symbolic forms" (Sherin 2001), related to the translation between mathematics and physics.
This example also shows that often neglected aspects of physics education such as the meaning of mathematical symbols may play a crucial role. Adding "human" model perspectives takes seriously the concrete experiences of learners and hence may contribute to enduring learning.
For learning physics the transparency in lying out all the necessary steps from everyday experiences to physical modelling and its mathematical description is essential. This approach of multiperspective modelling is going to be tested on circular motion with first year students of physics at university in order to evaluate its efficiency.

Keywords: modelling, circular motion

PS.07.02.a
Strand 3: Learning Physics Concepts
Parallel Session 07.02
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D501 (4th Floor)

Diagrams: facilitator or obstacle for understanding energy balances? A case study about greenhouse effect

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This study aims to provide some elements relating to the boundaries of education, scientific popularization and research in didactics. The research deals with a highly publicized subject, the greenhouse effect through the resources available on the internet and in textbooks with a focus on featured diagrams. Why this focus? Firstly, diagrams, more generally images, are a critical vehicle to convey a given message revealing the kind of implemented strategy and secondly they are sources of potential obstacles which could reinforce understanding's difficulties.
Understanding of greenhouse effect encounters a wide array of difficulties. Our focus is on "sequential reasoning" most often led by students to interpret phenomena. This linear causal reasoning constitutes a strong pitfall. First, the transitory phase with changes in temperatures and energy fluxes screens the steady-state situation when thermal equilibrium is reached. Secondly, the feedback between the Earth's surface and greenhouse effect gazes could be very hardly foreseen. Finally, it is difficult to combine a phenomenon in progress with respect to energy conservation and, therefore, to take correctly time into account.
In the framework of "Educational Reconstruction" and "Didactic Engineering", we have proposed guidelines to design a teaching learning sequence in grade 10. In particular, we emphasize a clear-cut decoupling between a causal explanation during the transitory phase and the expression of energy balances during the stationary situation. It is worth to notice that a single diagram could very hardly plays the two parts.
Starting from these research findings, we construct a diagrams' typology with several goals:
- Categorization of implemented strategies on the internet and in textbooks
- Search for similarities or differences according to the origin of documents
- Comparison to our own design's guidelines.
The main result is a common majority presentation: an "echo-explanation" supported by a single "graphic story". Apart from this majority trend, we notice various strategies supported by diagrams mixing up "graphic story" and "energy balance diagram", to simply bypass difficulties or to take them into account more or less deeply. Strategies' impact on greenhouse effect's understanding is discussed by noting that the compromise between understanding's facilitation and preservation of consistency is often difficult to reach. Even if the challenge is high, some rare examples show that it could be taken up, even for popularization understanding. Therefore, scientific popularization and teaching-learning are not to be opposed but a fruitful interaction is to be sought. The main issue focuses on the message to convey: in the case of greenhouse effect, is energy conservation to be put forward?
The diagrams' typology presented could be an interesting tool for a teaching-learning sequence or a teacher training session. In particular, "echo-explanations" supported by "graphic story" could be effective triggers, at least destabilizing elements, to question energy balance.
The large presence of "echo-explanation" questions its dissemination, especially in the educative community.

Keywords: greenhouse effect, energy balance, sequential reasoning, diagram, scientific popularization

PS.07.02.b

Strand 3: Learning Physics Concepts

Parallel Session 07.02

Date & Time: 04.07.2012 / 10:30 - 12:00

Room: D501 (4th Floor)

An investigation of university students' understanding of graphs in mathematics, physics and other contexts

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Scientific data are often communicated through graphs, which are a very condensed source of information used for effective summarizing and displaying of quantitative data. Graphs contain individual data points, but also allow the skilled user to quickly notice and extract important features of the data set under analysis, such as trends, rates of change etc. This is usually done through the analysis of graph slopes and areas under the graph. Students are introduced to graphs rather early in their education and through different school subjects. They acquire most of their knowledge about graphs through the study of mathematics and physics. However, students also encounter graphs in contexts other than those of mathematics and physics, such as biology, chemistry, everyday life, economy etc. The ability to interpret graphs is considered one of the important outcomes of high school mathematics and physics courses, and is often assumed by university faculty to be fully developed by the time that students enroll in university. This study investigates and compares university students' understanding of graphs accross three different domains: mathematics, physics (kinematics) and contexts other than physics (economy, biology, everyday life). The last domain did not require any substantial context - dependent knowledge. Eight sets of parallel mathematics, physics and other context questions about graphs were developed by authors. Questions were parallel in the sense that the required mathematical procedure for solving the question was the same in each set of three items. However, depending on the domain, the interpretation of the meaning of the obtained solution differed among parallel questions. A test consisting of those eight sets of questions (24 questions) was administered to 385 first year students at University of Zagreb, who were either prospective physics/mathematics teachers or researchers. The test was administered at the beginning of the first semester. Four sets of questions were multiple choice, and four were open ended, but in all questions explanations of the answers were required. Data was analyzed with the Winsteps 3.66 software for Rasch analysis, and linear measures for item difficulties were obtained. Average difficulties of items in different conceptual areas (graph slope, area under a graph) and in different domains (mathematics, physics, other contexts) were computed and compared. Analysis suggests that the concept of graph slope is of equal difficulty in all three domains, whereas the difficulty of the concept of area under a graph differs across domains. Mathematics was, for students in this study, the easiest of the three domains. It appears that addition of either physics or other context to mathematical items significantly increases difficulties of those items. No significant difference was found between average item difficulties in physics and in other contexts domain, suggesting that physics, as a context, was not easier for students than other contexts presented in the study, although all students had previously studied physics in high school. Some common student difficulties with graphs, that were identified through the analysis of students' answers and explanations, will be discussed. The findings of the study suggest that students' mathematical knowledge is not the most important factor for students' success in solving graph problems in physics or other sciences, and point to important differences in student understanding of graph slope and area under a graph.

Keywords: graphs, mathematics, physics, context, slope, area, Rasch model

PS.07.02.c

Strand 3: Learning Physics Concepts

Parallel Session 07.02
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D501 (4th Floor)

Physics learning instruments of the 21st century

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Along with the development of Humanity, Physics education passed four stages, each of them had its own physics curriculum and material carrier of knowledge: Pre-educational stage (ancient East and Egypt, accumulation of basic knowledge about the world, human communities); Initial educational stage (ancient Greece and Rome, schoolarization of education, teacher); University stage (Western Europe, bookinization of education, books); Computer stage (highly developed countries, informatization of education, PCs). At present, physics education is passing to the next stage – Internet stage (whole World, netization of education, tablets and mobile phones).
At this stage, there is an opportunity to transform radically both the content of teaching and learning instruments based on network multimedia. Simulation of major characteristics and properties of represented processes and phenomena by means of physical models can provide students with physics competences characterized by high cognitive parameters.
The following three aspects of creating physics learning instruments can be singled out:
1. information (knowledge itself);
2. technical (software);
3. technological (way of using knowledge and software).
Information aspect. Up-to date Internet technologies allow to structure physical knowledge in different formats using different software.
Technical aspect. Up-to date set of software allows to create learning instruments capable of demonstrating complex dynamic models and simulating real processes.
Technological aspect. Global network learning instruments allow to change the emphasis shifting it from the “Push technology” used at the previous stages when teachers imposed their views on the phenomena and processes to the “Pull technology” providing independent active learning.
We distinguish three methods of creating network physics learning instruments:
• H1H (home one home);
• H2H (home to home);
• H3H (home three home).
H1H involves learning within one network instrument. H3H means collective work in class (3 - teacher, students and learning instrument) to achieve common or individual aim. H2H means navigating from one Web page to other Internet resources to solve a problem and eventually going back to the initial Web page.
As a result, multimedia network instruments are able to create special physical learning space where students:
• get a sufficient amount of information;
• are offered up-to date computer instruments for decision-making;
• get physics competences through the use of new cognitive technologies.
Network instruments of learning physics allow to use all Internet information resources accumulated by Humanity and learn physics using PCs, tablets and mobile phones at any place and at any convenient time.
The learning instruments will be demonstrated during the presentation.

Keywords: Physics learning instruments, knowledge, software, physics competences

PS.07.02.d

Strand 3: Learning Physics Concepts

Parallel Session 07.02
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D501 (4th Floor)

Students´ difficulties with the concepts of direction and sense of a vector in the Mexican Education System

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Worldwide there are three conventions to define the direction of a vector. In the first convention, used in United States, the direction of a vector is in 2D an angle between the vector and a reference axis. In the second convention, the direction concept is assumed to have two separate properties: orientation (line of action) and sense (which way the vector points). The third convention, used in all Spanish speaking countries, is very similar to the second one; the only difference is that in this convention, the term "orientation" is not used to refer the line of action but rather the term "direction". In Mexico, this latter convention is usually used, however, because of its proximity to the U.S., the American convention permeates in this country too.

At the moment there are few investigations that focus on students´ understanding of the concepts of direction and sense among students enrolled at a Mexican university. We began this study with a previous research [1] that analyzes this understanding with students entering a large private university. In the present work we elaborate with greater detail students´alternative conceptions and investigate the persistence of these conceptions after finishing the introductory physics courses. The aim of this study is to investigate students´ alternative conceptions in the concepts of direction and sense, and the difficulties due to the coexistence of the two conventions.

We administered a test to 512 students finishing introductory physics courses at a Mexican university. Following the methodology presented in the previous research [1] we divided the sample into two groups. Half of the sample did a problem that asks to select vectors with same direction, in which students could choose which convention to use, and another problem, based on the convention of direction as line of action, that asks to select vectors with same direction and different sense. The other half of the sample performed only one problem, based on the same convention that asks to select vectors with same direction and sense. In the study we found that several students have alternative conceptions relating direction and/or sense with the regions formed between the Cartesian axes where the vector points, or with the angle that forms the vector with the x-axis. We also elaborate the difficulties due to the coexistence of the conventions. We found alternative conceptions in which students identified sense with magnitude or with direction as established in the American convention. We performed a comparative analysis between the two problems made by the first half of the sample, and found that these students are divided in different groups with different uses of the two conventions and with different difficulties in the direction and sense concepts. Based on the results, we describe a number of implications for the instruction of these concepts. For future research, it is considered interesting to investigate whether these difficulties are also found in other languages and other countries.

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Keywords: vector, direction, sense, direction convention, alternative conceptions

PS.07.03.a

Strand 14: Socio-cultural Issues

Parallel Session 07.03

Date & Time: 04.07.2012 / 10:30 - 12:00

Room: D502 (4th Floor)

Fear of radiation: What can be done

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Abnormal fear of ionizing radiation or 'radiophobia' is a deeply rooted socio-psychological problem for our society. Not only in the developing countries, but also in the technologically advanced countries, people are likely to believe unscientific reasoning about the effects of radiations.

Radioactive materials have been part of the earth from the beginning of its formation. So the radioactivity and radiation existed on earth long before the emergence of life. Radiation is an important aspect of human life. We interact with radiation from several sources, both natural and manmade. On average more than 6 mSv of radiation dose are exposed on us annually of which 3 mSv are from natural sources and 3.2 mSv come from manmade ionizing radiations. Ionizing radiations are widely used for diagnostic and therapeutic purposes and hence saving millions of lives every year. There are about 25 million people in the world living with cancer. Nearly 11 million people are diagnosed with cancer every year and more than 60% of them get curative and/or palliative treatment using ionizing radiations through radiotherapy or brachytherapy or nuclear medicine. About 14% of the world's electric powers are generated by using radioactive materials from over 440 commercial nuclear power reactors in 30 countries around the world. Nuclear energy is environmentally clean and hence not responsible for global warming.

Although the radiation is so useful, the radiation issue is a long time global taboo. General public do not understand clearly the concept of radiation energy, effective dose and the effects of radiation on life and environment. The concept of radiation is mainly transmitted by media (TV, newspaper, internet) especially after the occurrence of radiation accidents like Chernobyl or Fukushima. The information transmitted via media is often biased and sensational which increases the public's fear of radiation. Encouraged by the media, general public portray any nuclear accident as extremely dangerous event which can undermine human civilization causing millions of deaths, which is far from the truth.

It is true that radiation has potential health risks. Ionizing radiation has effects on living beings. Lots of research has been done and number of reports has been published on this issue. United Nations and its different organizations are continuously publishing reports for the public awareness of radiation effect. Radiation effects mainly depend on three factors - intensity, proximity and duration of exposure. If the amount of dose is high, the effects are also high. Close proximity to the radiation source will affect more, and the duration of exposure plays a key role in the radiation effects. Longer duration of exposure increase the risks. Radiation has short time and long time effects on human body. And also there are deterministic and stochastic effects. Induction of cancer due to radiation is a stochastic effect.

There are lots of other things that have risks for health and environment. But general public has a special type of fear for radiation. The word 'radiation' is perceived as a unique hazard. To reduce radiophobia, the radioactivity and their effects should be understood by the general public. One way to make the public more trusting of radiation issues is teaching radiation physics starting from the school level science education. Topics of Radiation physics are currently not included in the school curriculum in most of the countries in the world. If the students engage in activities that will allow them to understand how natural radioactivity is a part of our everyday environment and how radiation enters our lives in different ways, what are the effects of ionizing and non ionizing radiations in human health it would be easier to increase the public knowledge. Hence prevention of radiation accidents and controlling the spread of radiation contamination will be easier. It is very important to teach radiation physics in schools, especially for developing countries like Bangladesh and India where nuclear power will become major power-source in near future. Students' conceptions about effects of ionising radiations and how the teaching of radiation physics affects their conceptions will be discussed in this paper.

Keywords: Ionising Radiation, Radiophobia, Teaching Radiation Physics,

PS.07.03.b

Strand 14: Socio-cultural Issues

Parallel Session 07.03
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D502 (4th Floor)

Science teaching at hospital school: an activity theory approach

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This paper describes the science teaching in hospital schools. In particular we study the science teaching in a hospital school of Oncologic Paediatric Institute (OPI) of São Paulo (Brazil). Typically the goal of hospital schools is to prevent the exclusion and the school failure, as a form of social reintegration and child's and adolescent's self valorisation, offering conditions for the child to better understand his/her situation and condition, to recover abilities and basic school contents, aiming to adapt the children to his/her original school year as soon as possible, and to maintain the bond with the child's routine since the school was part of his/her daily universe and the school relationships were the space where she grew. The teaching environment allowed observing the exacerbation of the axiological dimension of the teaching activity in detriment of typically explored ontological and epistemological dimensions of science teaching.
Referential and research question
The research problem is characterized by highly complex institutional relationships that constitute the school's hospital at OPI. To study this school the theoretical framework of Activity Theory (Leontiev, 1989), specifically the third generation of Activity Theory (Engestron, 1989, 2001), was used.
Our working hypothesis is that the hospital school is a complex system of activities involving: student-patients' regular school and family, and hospital (OPI). Moreover, we can identify that there are relationships between these various hierarchical levels that interfere and contribute to the educational practice of the science teacher in the hospital.
The main research question of this investigation is: How do science teacher teaches in the OPI's hospital school? This leads to various hierarchical levels, from planning classes and their articulation with the planning of regular school until the teachers' continuous formation, since teachers have to deal with students at various stages of different oncopathia, families and doctors.
The activity structure at the OPI's hospital school was analyzed according to the principles pointed out by Engestrom (2001). The first principle presupposes the relationship between the collective activity system as the basic unit and the activities are mediated by artefacts and object-oriented. The second principle states multivocality of activity systems, since they represent a community of multiple voices, traditions and interests. The third principle includes the history, i.e., activity systems are transformed over time. Thus, its problems and potentialities can only be understood based on their own history. The fourth principle establishes the central role of contradictions as a source of change and development. Contradictions embody the historically accumulated structural tensions in and among activity systems. The fifth and last principle highlights the possibility of activity systems expansive transformations. This transformation is performed when the object and purpose of activity are reconceptualises to reach a wider horizon than the previous mode of activity. (Engestrom, 2001).
Methodology
An ethical agreement with Hospital's Ethical Commission allowed only interviews with teachers. No video recording during the classes or with students was allowed. Data collection was semi-structured Interview with teacher and school's coordinators, hospital official documents, in service teacher education course documents. The final sample of interviewed teacher was composed by 10 teachers (09 Physicists, 01 Biologists), 02 Coordinators (Physicist, Linguist).
Data analysis
Data was analysed using content analysis based on the interviews that were analysed considering four dimension: temporality, spatiality, instrumentality and finality. Those dimensions deals directly with the activity of planning classes and all of them are viscerally internalized in teachers at regular schools defining teachers' expectations with the hospital school.
Results
The analysis of the interviews made clear the complexity of relations between the elements of the activity systems – hospital, origin school and family – from the perspective of the science teacher. Several hierarchical levels of activities in the systems that make up the school hospital were identified, allowing establish the ways those activities interfered in science teaching. The dimensions of temporality, spatiality, instrumentality allowed identifying several contradictions between the science teachers' expectations and their actions as teachers in the school environment. But what really draw attention are the contradictions that arouse with the dimension finality (why do we teach science for those student-patients?). A lot of different senses was attributed to science in this situation flourishing, clearly, the axiological dimension of Science education.
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Keywords: Science teaching, Hospital classes, Activity Theory

Context- based physics: case-studies of teacher training and materials for Science education in road safety education

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Context and scientific learning are linked in several ways: learning is contextualized (being shaped by the phenomenological context of learning) and motivation for learning implies personal involvement of students, who occurs in context (Lave 1988, Taasoobshirazi & Carr 2008). It is increasingly necessary to provide a large context and in particular scientific knowledge should be placed not only in subject content related contexts but also in socio-cultural contexts of social kind. So there is a need of designing, proposing, revising the physics learning integrated into social issues. Among these a rich context is road safety education, where the scientific concepts play a crucial role. In some cases (such as the issue of Energy) physics concepts are evoked but they do not take the value of conceptual knowledge. What has the role of reference, evocation, application should be the ground to build conceptual knowledge as well as the context of meaning for the safety rules. Good examples of activities related to context-based physics, also concerning and traffic safety were proposed (Waltner, Wiesner and Rachel 2007; PLON, 1988; Parchmann, Luecken, 2010; Duit, Mikelskis-Seifert and Wodzinski, 2007). From these projects emerges that there is a great need to study how the conceptual knowledge of physics can be built in science & society contexts, thus grounding a new way of looking at the setting of both physics and science & society, not evoked but based on the fact that subject knowledge is built. This innovation in the way to look at contents to activate effective teaching-learning processes needs adequate teachers training. The Pedagogical Content Knowledge of teachers (Shulman 1986) must be developed and the joint design of the teacher as researcher with the researcher is the basis for a real change in teaching. Innovation is essential: the context of developing of subject content learning is modified and the subject content related knowledge becomes conceptual knowledge in the context of social issues. So it becomes an innovation centered on learning in unusual contexts in which the teacher is required not only for a redesign of the learning proposals but also for a new way of looking at the subject matter content. On the other hand there is the contextualisation of learning that requires the personal involvement of the student. Innovation should offer conceptual and manual operativity of the student that the teacher should make her/his own and put in the new learning project. Many dimensions are involved in this process: teacher professional development, ways to teach physics in different contexts, design-based research, proposals design.
A research was planned aiming to address these different levels, with the following research questions: how to promote the professional development of teachers in teaching and integrating scientific topics and the related traffic safety ? How is it possible re-organize the physics contents in the context of safety traffic to produce motivation and affective learning? How the teachers modify the proposal coming from research to implement in contexts different for level, topic treated, style?
Here we present and discuss the materials and how the design work of teachers was grounded. With regard to the materials we worked assuming Inquired Based Learning (IBL, McDermott et al. 2000) as a teaching method with strategies based on the exploration of the contexts in which formal physics quantities are built and the Model of Educational Reconstruction (MER, Duit et al. 2005) as a framework for the structure of the physics content in the proposals. We chose for dealing the issue of the motion in its levels of both description and aspects relevant to active rather than passive safety in the mobility. The activity was offered to teachers of primary/junior high schools of Friuli Venezia Giulia Region (North East of Italy) as part of a three-year project to promote road safety education in the school context, referred to as "SicuraMENTE"; in the first two years 40 teachers of different subject areas, involved in education of traffic safety in their schools, were involved in the training, in two successive steps. As preliminary results we analyzed the process activated in teacher education and the first design plans and implementations of the teachers. The main added value of the teachers plans and implementations emerges from the integration of the competences of teachers in treating problems about traffic safety in different topic s and the researcher competences in scientific education. Different content subjects was inserted and proposed to pupils in new contexts, creating motivation, integrated learning of both scientific and safety aspects, improvement in teachers' PCK, good practices as suggestions for curricula innovation.

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Keywords: road safety education, context-based physics, teacher education, curricula materials

PS.07.03.d

Strand 7: University Physics

Parallel Session 07.03

Date & Time: 04.07.2012 / 10:30 - 12:00

Room: D502 (4th Floor)

Energy Solution for the coming Generations!

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Human being is searching energy sources to meet his needs since the dawn of civilization. Majority of the current international conflicts are traceable to disputes over energy and materials rich areas. Energy use rate is increasing 3-5% per year throughout the world because of the population growth and the increase in energy input per capita. Non-nuclear fuels like coal, oil and gas (included undiscovered reserves) are expected to deplete in around one century with 4% projected rate increase. Solar, winds, tides and water are other sources in some localities but do not at present look hopeful. With current resources, without improvements in efficiency in the above mentioned we will need 80% more energy by 2020. Even with efficiency improvements at the limit of technology we would still need 40% more energy.

Two diametrically opposed nuclear processes, fission and fusion can yield large amount of energy and can solve the needs for energy. This can contribute to the peaceful relations among mankind. In fission one (heavy) nucleus is split by a neutron into two (or more) parts of different mass releasing energy with some neutrons. Naturally, U235 nuclide is fissionable and suitable for use in most reactors as fuel but unfortunately the reserves are not very great and the problem of disposal of radioactive waste is severe with fission reactions.

The second option is Fusion, it powers the sun and stars as hydrogen atoms fuse together to form helium, and matter is converted into energy. Hydrogen, heated to very high temperatures changes from a gas to plasma in which the negatively charged electrons are separated from the positively charged atomic nuclei (ions). Normally, fusion is not possible because the positively charged nuclei naturally repel each other. But as the temperature increases the ions move faster, and they collide at speeds high enough to overcome the normal repulsion. The nuclei can then fuse, causing a release of energy. With current technology, the reaction most readily feasible is between the nuclei of the two heavy forms (isotopes) of hydrogen - deuterium (D) and tritium (T). Each D-T fusion event releases 17.6 MeV (2.8 x 10-12 joule, compared with 200 MeV for U-235 fission).

The use of fusion power plants could substantially reduce the environmental impacts of increasing world electricity demands since, like nuclear fission power, they would not contribute to acid rain or the greenhouse effect. Fusion power could easily satisfy the energy needs associated with continued economic growth, given the ready availability of fuels. There would be no danger of a runaway fusion reaction as this is intrinsically impossible and any malfunction would result in a rapid shutdown of the plant. The World is about to construct the next step in fusion development, a device called ITER. ITER will demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes. It will produce 500 MW of fusion power with cost, including R&D, is 15 billion dollars. This will put the research effort into new regime of burning plasma science.

PS.07.04.a

Strand 6: Secondary School Physics

Parallel Session 07.04

Date & Time: 04.07.2012 / 10:30 - 12:00

Room: D402 (3rd Floor)

Multiple representations about sound propagation of the 8th grade students

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Connecting representations can have students to get rich understandings of science concepts. But research results reported that many students can use just one representation or 2-3 contradictory representations and many representations about sound propagation in textbooks are not easy to figure out the meanings and editors' intentions. In this study, learning progressions of students' multiple representations about sound propagation are investigated to find the way for helping students to connect representations and escape from contradictory understandings between representations. A four hour teaching and learning sequence focused on connections between representations about sound propagation has been developed. Tht teaching and learning sequence includes activities such as analyzing voice of oneself, vibrations of sounding wine glasses and computer simulation. In each activity students were asked to represent their ideas of sound propagation by different representations in different conditions. The middle school students attended one public school and one private in a large-sized Korean city where they enrolled in a 8th-grade science classes. The number of participants are 209. Their responses were categorized and analyzed qualitatively. As the teaching and learning sequence progressed, students' representations were getting rich. But in some cases, contradictions or no-connections between multiple representations of one student could found. These results could suggest that the developed teaching and learning sequence is effective on enriching representations. But it seems to be refined strategies of connecting representations.

Keywords: multiple representation, sound propagation, secondary school

PS.07.04.b

Strand 6: Secondary School Physics

Parallel Session 07.04
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D402 (3rd Floor)

Project-based learning outcomes at The Bosepo as the unique students' competition in Sarajevo

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Learning environment for secondary school students in Bosnia and Herzegovina (BiH) is mainly traditional one which lacks demonstrations, experiments or infrequently active student's role. There are several reasons for dominant teacher-centered teaching/learning physic methodology at secondary school level, but we witnessed that to activate students to learn science and particular physics by project-based activities expressing themselves in scientific environment is something possible at the BOSEPO (Bosna Sema Energy / Environment / Engineering Project Olympiad). Melanie Bradford (2005) emphasized that project-based learning brings many opportunities "that are interdisciplinary, student-centered, collaborative, and integrated with real-world issues and practices". This statement is in the ideas' nucleus of a group of educators who initiated BOSEPO as a unique event for students, their parents, friends, and also for their teachers in BiH. Joseph Krajcik et al. (1998) highlighted based on their research results how is project-based learning important in the inquiry process in science education that is now for new generations a central educators' mission to educate in many dimensions of culture, economy, politics streamlines that each society needs to meet the 21st Century sustainable development. In this paper we aimed to show the effectiveness of BOSEPO outcomes at many different levels of influences for both students and their teachers.
BOSEPO is a groundbreaking science fair open to high school student. BOSEPO is organized with a mission to establish university preparatory schools focusing on math, science, engineering, and computer technologies in an effort to provide a world-class education to public. BOSEPO participants have been included in the learning process based on creating ideas and models, science, math and computer science knowledge applying in a full scientific manner that is required. Students have confronted using their knowledge and creative thinking to prepare following application elements.

- Project abstract (the first step in project selection by BOSEPO Commission)
- Project journal (written document about student's project ideas and work with recorded results as they are produced)
- Research paper (written in English, with sessions all required as a cover page, table of content, abstract, introduction, used material and implemented method, the achieved results, discussions, acknowledgments and references)
- Project products (poster, experiments, devices invented, and other proof presented in the journal and research paper)
- Project exhibition participation during BOSEPO fair and competition in the university environment as a host institution (International Burch University in Sarajevo)

Students' projects are under very strict assessment by BOSEPO judges who are members of the academic community from several universities in BiH. Students receive up to 10 points according to the ten criteria.

- Creativity/Originality (Originality of the problem; unique approach to solve a sustainability issue.)
- Review of Literature (Research of scientific literature and use of references.)
- Scientific Thought (Statement of hypothesis; clarity of purpose; identification of all relevant variables)
- Scientific Method (Evidence of depth of study and effort in employing scientific procedures; proper methods followed for experimentation and investigations.)
- Data Management (Proper recording and display of data in tables, charts, and graphs; proper analysis of data.)
- Conclusions (Drawing logical conclusions, consistency of conclusions with obtained data; recommendations for further research.)
- Applications (Practical applications of the project; benefits for society in certain ways.)
- Research Skills and Effort (Level of skills and effort by (each) researcher to carry out the project; amount of work; high level of understanding of the techniques and equipments used to gather data.)
- Understanding the Project (Each) Student's understanding of each step during the implementation of the project.)
- Quality of Presentation (Well organized display; project journal.)

The number of the students from 6 high schools in the last two BOSEPO competitions is 286 (38 % Females, 62% Males); they have competed with136 projects under the auspices of 55 supervisors and 53 BOSEPO juries. 39 %, 34 % and 27 % of students prepared their projects in the field of engineering, environment and energy, respectively.
According to the university professors' feedback, who participated as judges, one can meet many carefully prepared projects which the students with the help of their tutors and parents spent nearly three-month work themselves. The most important outcome of BOSEPO competition is the participation of a large number of students who have experienced the way a scientist has, working mostly in pairs or groups of 3 students, self-learning from a variety of scientific references (the textbooks, scientific books, scientific journals, project

reports, etc.).
On the other hand, students with a clear educational purpose have been directed towards science and scientific research, innovative activities, creative thinking and practical application of integrated knowledge from different fields of their education and interests.
We believe that BOSEPO should expand its activities among high school students throughout the country, but hopefully and wider. This is of particular importance to cultural level to meet and exchange ideas of students and their educators from various regions of BiH. BOSEPO initiatives could bring young people closer and let them use their ideas to develop BiH society and carry their country to the equal position with other countries in the Balkans and in the world.
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Keywords: high school learning, practical application of integrated knowledge, project-based learning, students’ exhibition and competition

PS.07.04.c

Strand 6: Secondary School Physics

Parallel Session 07.04
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D402 (3rd Floor)

Impact of IBSE methods and IBSE materials on students´ learning

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This study reports on the use of Inquiry-based science education (IBSE) materials and activities on the concept of Sound that have been used to teach lower and upper secondary school students by teachers who have participated in IBSE teacher education in three different countries (Slovakia, Italy, Ireland). An IBSE method has been adopted by the ESTABLISH project (FP7, 2010-2013) to promote the implementation of innovative teaching and learning approaches for student-led inquiry based activities in the classroom. An IBSE approach is considered to encourage students´ active involvement in their learning compared to traditional methods. This project has developed teaching and learning materials for teachers and students that facilitate inquiry-based learning. An inevitable presumption to the effective implementation of IBSE is a well-trained teacher who is confident and competent in the appropriate use of IBSE methods of teaching. Hence, in-service teachers have participated in at least 10-hours professional development training to experience and develop their inquiry based teaching strategies using specifically developed materials. However, for any change in teaching methodology and/or curricula to occur, evidence must be clearly shown of its value in teaching and its impact on student learning. Therefore, the participating teachers implementing IBSE within their classrooms are provided with instruments and tools to collect information from students as well as collect teachers´ feedback about the impact of IBSE on their students. Evidence of the impact of this approach and materials has been collected from both the participating teachers and their students and the results and feedback of this teaching approach and the impact of IBSE on the students will be presented. In particular, the impact on students' appreciation of the importance of science and technology in society, the impact on students´ inclination towards taking up careers in science and the impact on intrinsic motivation for learning science will be discussed.

Keywords: inquiry-based science education, teaching physics, teacher training, sound, motivation

How IBSL (inquiry based science learning) is the IBSL approach?

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The recent curriculum changes in Flanders moved the educational approach from science learning towards enquiry based science learning. With the introduction of the curriculum for the new course "natural sciences" [1] (which was introduced September 1st, 2010) and the adapted curriculum for the existing course "scientific initiation" [2] (of which the last version was introduced September 1st, 2010) for 12 – 14 yo students, the learning strategy for IBSL is covering the full secondary education now (12 – 18 yo students).
Using the Laboratory Structure and Task Analysis Inventory (LAI) [3] developed by Furman (1978), the newly published course books are analyzed for a same scientific topic. What are their strengths, what are their weaknesses and where are the gaps? Are experiments and contexts motivating and inspiring? Do their experiments lead to further ideas or experiments? Can their experiments be planned and designed by 12 – 14 yo students? Do they really enhance IBSL?
Gaps are detected and suggestions for improvement, related to the LAI, are made. Classroom experience with the suggestions given will be presented and discussed with the audience.
Example: All "scientific initiation" course books cover the topic of mass and gravitational force. After the introduction, the classic experiment is introduced: measure the mass of an object, attach the object to a dynamometer and write down the results in a table. Repeat this action several times and draw the graph, which leads to the well-known formula.
It's a good experiment, however it doesn't really enhance IBSL (since the students just follow the instructions).
Suggestion for improvement (example 1): Give the students a lot of tools and objects and let them design (in small groups) an experiment that looks for the link between mass and gravitational force. During this process, the teacher becomes a coach to discuss their ideas and to give indications for fine-tuning.
Suggestion for improvement (example 2): Give the students the formula. Give them also a lot of tools and objects and let them design (in small groups) an experiment that leads to the empiric proof of the formula. Again, the teacher becomes a coach to help and motivate the students.
Ideas for contexts outside the suggestions in the curricula will also be presented and discussed with the audience, as well as classroom experience with these ideas.
Example: The topic of mass, volume and mass density is covered in all "scientific initiation" course books. Generally, the topic ends with the study of buoyancy. Why end here? Why don't we encourage our students to study buoyancy with a hands-on approach?
Suggestion: Let the students work together in small groups. Let them draw a construction plan of a boat, to be built with everyday materials. They will present their construction to the teachers and the class, and they can change their construction plan. Afterwards, they start building their boats. This leads to the evaluation: does the boat not sink, is the boat really built like the construction plan, how many concrete bricks can the boat carry before sinking,…
As a conclusion, tips and tricks for a better IBSL approach will be presented.
[1]: http://ond.vvkso-ict.com/vvksomainnieuw/leerplanpubliek.asp?NR=2010/001
[2]: http://ond.vvkso-ict.com/vvksomainnieuw/leerplanpubliek.asp?NR=2011/009
[3]: Fuhrman, M. (1978). Development of a laboratory structure and task analysis inventory and an analysis of selected chemistry curricula. Unpublished master's thesis, University of Iowa.

Keywords: IBSL, inquiry based science learning, curriculum review, course book review, improvement suggestions, classroom experiments, classroom experience

PS.07.05.a

Strand 7: University Physics

Parallel Session 07.05

Date & Time: 04.07.2012 / 10:30 - 12:00

Room: D403 (3rd Floor)

Conoscopic figure formation through experiments with anisotropic materials

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To implement new topics that are connected with students' everyday life in physics education, we have to choose properly among the wide list of possible topics. Such a topic should be actual in research and also in application or in students' everyday life. Liquid crystals are one of those topics. They are used because of their unique optical properties, which are the consequence of their anisotropic structure. A scientific method to measure those optical properties or better the optical indicatrix of the matter is called conoscopy.
How to introduce the properties of liquid crystals was already described in literature, for example in [1]. Their properties can be shown also with wood models [2,3]. But the optical properties of anisotropic materials and furthermore, the formation of conoscopic figures, can be easily shown, with the use of other anisotropic materials, like scotch tape or transparency.
We present a set of educational experiments for the university level that systematically present which properties of anisotropic material influence the light passing through the anisotropic material and consequently it presents how the conoscopic figure is formatted. Within the experiments, students are measuring or observing the intensity of the light passing through an anisotropic material between two crossed polarisers. Easily achieved hand-on experimental equipment like laser beam, transparency, polarisers, spectroscopes, microscope slides and scotch tape are mostly used. To measure the intensity of the transmitted laser beam, a simple device with a photodiode and a voltmeter was constructed. Students can study the light intensity in dependence of the thickness of the material, the wavelength of the light and the angle of incidence.
All the experiments allow for inquiry based active learning and students may get familiar with the phenomena related to birefringence, study the parameters that influence the polarization of the light passing through the material and finally achieve the understanding of the conoscopic figure formation.
The sequence was tested on the first year physics teacher students of the Faculty of education of University of Ljubljana, Slovenia. Some of the experiences will be presented.

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[2] Ziherl, S. et al. (2010). Eur. J. Phys., 31, 531-542.

Keywords: Anisotropic material, Liquid crystals, experiments

PS.07.05.b

Strand 7: University Physics

Parallel Session 07.05
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D403 (3rd Floor)

Demonstration of the angular dependence of the extraordinary refraction index

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Comprehension of the concept of birefringence can be significantly improved by carefully chosen experiments. We present and compare two such experiments: the wedge liquid crystalline cell is used at optical wavelengths (Shenoy, 1994) and suitably cut pieces of wood (Ziherl, 2010) at wavelengths in the microwave region. In both experiments the existence of two refractive indices is demonstrated and the angular dependence of the extraordinary refractive index is measured.
We show an experiment using the wedge cell filled with properly oriented liquid crystal in a uniaxial nematic phase. Transmitted light is split into two perpendicularly polarized beams and the ray directions can be deduced from the positions of the light spots on the screen. Since the extraordinary refractive index depends on the direction of light propagation, the position of light spots depends on the orientation of the wedge cell. As large refraction indices limit the experimentally accessible directions of light propagation within the liquid crystal, we overcame this difficulty by using a sandwich of two equal prisms having the wedge cell between them and measured the extraordinary refractive index as a function of the direction of propagation between 0 and 90 degrees.
It is widely accepted that analogies can be very helpful in improving comprehension of new phenomena and physics is no exception. Wood is an example of an obviously anisotropic material due to visible fibers. Since it is transparent for microwaves many anisotropic properties can be illustrated by wood samples and a simple school microwave kit (consisting of a microwave transmitter, a microwave receiver, and a multimeter). A particular advantage of wooden samples in comparison to liquid crystalline cell is that wood can easily be cut in any direction. It is therefore easy to make wood samples with the desired fiber orientation and shape. By using a suitably cut wedge of wood both eigenvalues of the refractive index are measured. On the other hand, parallel plates with different fiber orientation are used to measure the angular dependence of the extraordinary refraction index.
The experiments presented above help to introduce the anisotropy and lead to qualitative understanding of the birefringence of the anisotropic materials at the microscopic (liquid crystals and visible light) and macroscopic (microwaves and wood) level. At the pre-university level they can also be used to introduce the direction dependence of physical properties, while the quantitative insight is achieved through measurements performed at the university level. The pilot study of experiments was performed in a group of in-service physics teachers at the Faculty of Education, University in Ljubljana. Results will be reported.

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Keywords: Birefringence, liquid crystals, wood, microwaves, refraction index, angular dependancy

PS.07.05.c

Strand 7: University Physics

Parallel Session 07.05

Date & Time: 04.07.2012 / 10:30 - 12:00

Room: D403 (3rd Floor)

Introductory students' difficulties in applying the ray model and the wave model of light in novel context

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The ray model and the wave model of light have proven difficult for students to grasp. They tend to fail in recognizing the conditions under which these light models are valid [1]. In addition, students seem to inappropriately combine the features of these models [1, 2]. Tutorials in Introductory Physics (tutorials) has successfully addressed these difficulties [3-5], and they have been taken into account in the introductory level physics textbook by R. D. Knight [6].

Despite the extensive former research behind these materials, only minor attention has been paid to students' abilities to apply the ray model and the wave model of light in a context where the light source changes. Our aim is to fill this gap by answering the following research question: What types of difficulties do introductory students have in applying the ray model and the wave model of light when the light sources and the sizes of apertures are altered?

A total of 78 students answered the paper-and-pencil test questions at the end of the introductory course Basic Physics IV at the University of Eastern Finland. The course followed the textbook of Knight [7] and the tutorials Light and shadow [3, 4] and Two source interference [3, 5] were employed.

The results showed that the students had difficulties in recognizing the conditions under which the ray model and the wave model are valid. These difficulties were connected to the type of the light source. About a fourth of the students only applied the ray model when a bulb was used as a light source. This tendency was more general among the students who had participated in the tutorial Light and shadow. In the case of a laser, about a third of the students applied the wave model that led them to the incorrect prediction. Even when the students selected the suitable light model, about a fourth of them misinterpreted the role of diffraction and the meaning of the equations describing the angles or positions of dark fringes.

These findings suggest that the given instruction was inadequate for developing sufficient understanding of these light models. In order to improve the instruction, the features of different light sources need to be discussed more explicitly by illustrating how they impact on the applicability of these light models. This might also open new possibilities to introduce the modeling nature of physics at the introductory level. During the presentation, we will present concrete ideas for taking different light sources into account in teaching introductory physics and discuss the practical challenges that are expected in their implementation.

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Keywords: students' difficulties, light sources, the ray model and the wave model of light

PS.07.05.d

Strand 7: University Physics

Parallel Session 07.05

Date & Time: 04.07.2012 / 10:30 - 12:00

Room: D403 (3rd Floor)

Research based teaching sequence on Electromagnetic Induction

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We present a pedagogical approach to address students' difficulties, identified in a previous study, in the learning Electromagnetic Induction. The teaching approach developed in this work proceeds from the fundamental assumption that learning and teaching sciences is developed as a process of the solving of open tasks or problems which students could find interesting. An initial analysis was undertaken to set out the problems that were to be tackled by the students and anticipate what prior knowledge would be necessary for the students to solve these problems. The framework suggests three areas for prior analysis: (a) epistemological: analysis of the content structure, the problem they answer, their designing and evaluating research-based instructional sequences historical genesis; the way science works; (b) psycho-cognitive: students' reasoning and conceptions; (c) attitudinal: STS implications, educational relevance of contents, linking between topics, everyday life and technological implications. The first area involves both the discipline's theoretical knowledge base (how it explains natural phenomena) and how science works (its form of reasoning and justification). In the third area context, ethical and social implications are taken into account, as is the complex relationship between science, technology, and society.

The approach was developed within a rigid timetable and the programme of Physics for Engineering was the same for all the students participants in this study. The study groups were organised into small groups of four students which carried out the proposed activities and then discussed their conclusions with the whole class, under the teacher's management and guidance. The students work with the same methodology throughout the whole course, so the methodology used in the "electromagnetic induction" chapter is not new to them.

In order to evaluate the teaching sequence, we provide and discuss some quantitative (comparing large experimental and control groups) and qualitative elements, using analyses of tape-recorded debates among the students. These questionnaires and interviews were designed with two objectives. The first objective was to quantify how much students have improved conceptual learning about electromagnetic induction. The second was to find out how students have evolved learning difficulties that were detected in previous studies. In the oral presentation will be presented the pre-test and post-test design and the results. They show that the elements within the teaching sequence help students to reconcile an overall description with electromagnetic induction and the Faraday`s.

Keywords: Teaching Secuence, University physics, Electromagnetic Induction

PS.07.06.a

Strand 8: Initial Physics Teacher Education

Parallel Session 07.06

Date & Time: 04.07.2012 / 10:30 - 12:00

Room: D404 (3rd Floor)

Knowledge differences of experts and future science teachers on basic aspects of radioactivity

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Rationale and the need for the study
Public understanding and knowledge of radioactivity could influence their opinions about for example the 2011 disaster in Japan. The public must be encouraged to engage with issues linked to radioactivity, but this is often an area charged with emotions and feelings (Alsop, 2001).
Decision making is shaped by understanding and attitudes, which are influenced through social, political, economic and cultural settings (Solomon, 1987 and Watts & Alsop, 1997). Examples are from Germany and France. In Germany it was decided to shut down nuclear power stations by 2021 which would be hugely damaging to the country's industrial base (BBC News, 2011) while 80% of domestic electricity comes from nuclear resources in France (Embassy of France, 2009). South Africa has 2 nuclear reactors generating 5% of its total electricity (World nuclear Association, 2011).
Aim
Science teachers should aim to prepare students for life in a scientific and technologically developing society and should also improve the understanding of science (Colclough, 2007). We therefore would like to investigate what knowledge future science teachers have on basic aspects of radioactivity as compared to experts in the field.
Participants
The population selected for this study was drawn from pre-service teachers from B Ed FET Natural Sciences (Physical and Life Sciences) and B Ed Intermediate and Senior Phase General Science. The students (N = 89) were from the 2011 cohort of the Faculty of Education at a University in South Africa. The respective populations of student teachers were the following: physics students with formal training in physics (N= 25), general science with emphasis on science and society (N= 28) and biology students with no formal training in physics (N = 36). These future teachers were specifically chosen because our assumption was that students who had more content knowledge in this case the physics students were supposed to demonstrate a better understanding of radioactivity because they had been exposed to the topic for longer and in more depth than the general science students that were exposed to the topic for less time and the biology students who had no exposure to the topic at all.
A purposeful sample of 4 experts (2 nuclear energy engineers from industry and 2 professors in physics) were chosen to investigate the knowledge difference between the experts and the mentioned groups.
Theoretical framework
The deficit model underpin the assumption is that there is a lack of public understanding and knowledge and this could lead to a climate of scepticism towards science (Sturgis & Allum, 2004). This model sees public resistance to science as supported by ignorance, superstition and fear. The public in our study was presented by biology students who did not have formal training in radioactivity.
Methodology
A non-equivalent expo-facto group design was used because three different groups were considered and not equivalent because the participants are from three different subjects areas. The participants did not receive any deliberate treatment only the normal course content.
A questionnaire was administered to all the groups (N = 89). It was developed by Colclough et al (2011) in their study to determine pre-service teachers' subject knowledge of and attitudes about radioactivity and ionising radiation. These student teachers had to answer the 25 questions comprising of a 6 point lickert scale and indicate the reasons for their answers. The questionnaire was handed to the students out at exactly the same time to ensure that no contamination took place. This was not the case for the experts because they were from different locations.
Findings and results
All experts were confident that they will use radioactive sources in demonstrations or hold it in their hands. Only 32% from the physics group would hold a radioactive source while nobody from the biology and only 7% of the science group would.
Experts as well as the physics and science groups seem not to mind eating fruit placed near a radioactive source. The most noticeable response was from the biology group. Only 8% of them would eat a "thin skinned" fruit (apple) but 5 times more were prepared to eat the "thick skinned" fruit (banana).
There was no significant difference in the answers of the 3 groups with regards to the environment but varied from the experts. On average 11% indicated that radioactive waste can be safely disposed in the sea while 50% showed that a nuclear power plant in perfect working condition emits dangerous levels of radiation into the environment.
Biology students (47%) thought that radioactivity can cause living things to glow green and consider radioactivity as an intervention of mankind. They also indicated a person's body cells can become radioactive

(56%).
Conclusion
Biology students representing public understanding differs considerably from the experts on questions related to the environment and health but this was not the case for the physics and general science students. In the questions related to the application of content knowledge, the physics and general science students were more comparable.

Keywords: Radioactivity, experts, knowledge, student teachers

PS.07.06.b
Strand 8: Initial Physics Teacher Education
Parallel Session 07.06
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D404 (3rd Floor)

Variation in the Representations of Pre-service Physics Teachers in Image Formation and Observation Process

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Recent studies in science and physics education research have shown that students have difficulties in image formation and observation process in geometric optics. Several studies have been conducted on understanding image formation and observation in several grade levels (Bertamini and Parks, 2002; Galili, Goldberg and Bendall, 1991; Galili, 1996; Goldberg and McDermott, 1986; Jones et al., 1994), but the number of in-depth studies on pre-service teachers is limited. Teachers are considered as one of the most crucial source of student conception, for this reason studying teachers' representations that they use to describe their conception is important to understand student conceptions. With this aim in this study pre-service physics teachers' representations in geometric optics is discussed. More specifically, the research question to be investigated here is "what are the representations used by pre-service physics teachers in explaining their conception about image formation and observation in a plane mirror?" The current study was carried out with phenomenographic approach. Phenomenographic studies mainly deals with the variation in the ways certain phenomena are experienced or handled by people of interest (Marton, 1989; Marton and Booth, 1997). The sample of the study comprises 53 pre-service physics teachers who took geometric optics and geometric optics laboratory courses in their program from three state universities in Turkey. The data were collected through an open-ended test developed by the researcher in the topic of geometric optics. Two of the items in the plane mirror context were selected for the detailed analysis for the current study. As a result of thorough analysis of available data, several qualitatively different representation categories were identified for the image formation and observation process in the plane mirror context some of which ends up with a scientifically correct results for the questions of interest; whereas some others resulted with non-scientific results. The primary significance of the results of this study lies in its identification and description of this variety in the representations to the interested researchers in the topic; as well as providing teachers and teacher education faculties with useful information to take into account in their instructions in the topic.

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Keywords: Physics education,pre-service teachers, representations, image formation and observation

PS.07.06.c

Strand 8: Initial Physics Teacher Education

Parallel Session 07.06

Date & Time: 04.07.2012 / 10:30 - 12:00

Room: D404 (3rd Floor)

Multiple representations in the experimental study of Classical Mechanics

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Many researches in multiple representations have been done in the context of looking for differences between experts and novices during physics problem solving. Others researches are focused to help students to make the link between concrete elements in real world and abstract representation of physics. In this last sense is our own investigation. We are working with undergraduate students enrolled in calculus-based introductory physics lab and we are investigating how learning skills can be improved by using multiple representations in the experimental study of classical mechanics, within small teams of four students engaged in a collaborative work. We find that when students are involved in a scientific inquiry, they begin their own investigation by applying their previous knowledge on the theme of study, mixed with their misconceptions. Particularly, in the study of the movement we are applying the next strategy in order to improve the initial point of view of students. First, we begin with conceptual maps of each student, followed with a conceptual map of groups of four students made after a consensus discussion. Finally in this stage we discuss with the entire group a conceptual representation of movement. Second, we propose to the groups of students, four individuals each, to study experimentally a particular case of movement. Before begin the experiment they must make, individually and collectively, a diagrammatic representation of the purpose of the investigation, describing it with the use of the most abstract elements that they can employ to clarify as much as possible the physics of the situation. With the new ideas over the theme, the different groups of four students make an experimental study of the movement of the objects that they are using in their investigations (balls, cars, gliders, people, etc.). They track the movement of the object with a video camera and collect data from the video with special software. With the aid of the software, the students make the graphical analysis of data to find the equations that represent the movement. For students, all this process means new representations of the movement. The real movement is seen as a sequence of frames in a video, that are transformed in points in a graphic and then to an equation that is an abstract description of the movement. The level of representation goes from the concrete and real to the abstract and symbolic. With this process we have the necessary elements to build with the students a model of the movement or its approximation that can be simulated in a computer to go back to the real world doing predictions and new observations. We do that experimentally, numerically, graphically, symbolically, conceptually or by using physlet simulations. At the end, we evaluate the new representations of the movements made by the students with the previous ones. In this work we present the complete steps of the representation that are investigated in the process described before and the results obtained.

Keywords: Experimental mechanics, learning, representations.

Physics teaching orientation influences on use of multiple modes of representation: Perspectives of Manitoban preservice teachers

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The fundamental question of this research study was to determine preservice teacher perspectives of their pedagogical orientations towards integrating different modes of representation, namely; visual, graphical, symbolic, and numerical, to enhance student learning. Bruner's (1966) description of the enactive, iconic, and symbolic modes of representation, and Gilbert and Treagust's (2008) work with macroscopic, submicroscopic, and symbolic representations provided the theoretical framework that was used to identify multiple modes of representation in teaching and learning. The Manitoba curriculum describes incorporating different modes of representation of physics phenomena as a way to improve conceptual development. Recently released results of the Pan-Canadian Assessment Program (PCAPs), and the Programme for International Student Assessment (PISA) both indicate Manitoba is near or at the bottom of Canada's provincial rankings in terms of student achievement and understanding of science. Research suggests that effective use of multiple modes of representation in the teaching of physics enables students to develop the deeper conceptual understanding needed to help reverse this trend. Surprisingly however, the specific learning outcomes (SLO's) in the Manitoba physics curriculum favours symbolic representation. As a result, students who require multiple representations to aid in their learning are placed at a significant disadvantage. This trend cannot continue.

The overarching goal of this pilot study was to determine the orientations of preservice teachers in using multiple modes of representation of physics phenomena towards enhanced student learning. Utilizing qualitative interviews and problem solving sessions with eight Manitoban preservice physics teachers enrolled in the teacher education program at the University of Manitoba, participants answered four sets of questions. Questions were specifically selected to identify the participants' pedagogical strategies and tendencies, as well as the use of modes of representation. These questions were based on: Gupta and Elby's (2010) basic kinematic expression analysis; Schoenfield's (1992) two-ball problem; Gupta and Elby's (2010), and Hammer's (1994) modified Atwoods machine; and finally, those used to identify the symbolic representation of physics phenomena as inspired by Dolmert, Airey, Linder, and Lippmann Kung (2007); Hechter (2009); Lising, and Elby (2004); and Louca, Elby, Hammer, and Kagey (2004).

Data was analyzed through Grounded Theory approaches (Creswell, 1993; Glaser & Strauss, 1997; Strauss and Corbin, 1990) to generate possible explanations for the trends emerging from the data. These results were superimposed over the participants' physics teaching orientations and pedagogical choice for modes of representation. Results from this research indicate that although preservice teachers intend to integrate multiple modes of representation in their teaching, they tend to favour a theoretical plane of learning as opposed to an experiential one. This aligns well with the Manitoba physics curriculum bias towards use of symbolic representation, but not with improving student learning and conceptual understanding in the province. As Manitoban preservice teachers do not seem to incorporate multiple modes of representation naturally, they need further direction to better address this in the classroom setting. It is therefore imperative that teacher education programming, as well as professional development opportunities, provide situational learning to help teachers use multiple modes of representation more effectively.

Implications of this study impact educational research involving modes of representation in classrooms, as it seeks deeper insight into the relationship between teachers' thinking and their pedagogical strategies, thus directly influencing the nature of student learning in their classrooms. Further, secondary level teachers, policy and decision-makers, and divisional and provincial science curriculum consultants will benefit from this examination of the nature and biases of the SLO's within the provincial physics curriculum.

Keywords: Preservice teacher education, modes of representation, physics teaching orientations

PS.07.07.W

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 07.07 Workshop
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: Smart Class

Scientix: easy to find high quality asience and maths teaching resources

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[1]Escola secundária dom manuel martins
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The objectives of the Lisbon declaration (2000) and the affirmation of the European Commission that there is a need to promote more widely inquiry based science education methodologies in primary and secondary schools and to support teachers' networks (2007), were the basis for launch by European Schoolnet (EUN) of Scientix, a new web-based information platform for science education in Europe. Its aim is to ensure the regular dissemination and sharing of progress, know-how, and best practices in the field of science education and providing a feedback mechanism.
Scientix is a three-year project run by EUN since December 2009 on behalf of the European Commission Directorate – General for Research and Innovation and is funded under the 7th Framework Programme. The portal (http://scientix.eu), available in six European languages, offers a resource repository containing hundreds of teaching materials from European projects, but also research reports and policy-making documents; a translation on demand service for the teaching materials towards any of the 23 languages of the European Union; a community including a forum and chat rooms; an online news service featuring international science education topics and a calendar of forthcoming events and training opportunities; and also a newsletter sent once a month to registered users. The portal allows for interaction among the registered users in the public profiles directory and for searching, commenting and rating the resources.
Scientix targets mainly teachers, providing teaching materials, scientific support and documentation that give them some quality tools for the development and implementation of inquiry based science education teaching methodologies.
This workshop will help the participants creating an OpenId account as well as a public profile in the members directory and show them examples of what they can do with this platform. The communities of practice will be shown and entrances will be asked to the participants. They can benefit by experimenting some resources available on the platform.
The workshop will be carried out in a room with one computer/ two participants with Internet access, in order to allow them to participate actively to the workshop.
Since resources are online, no materials will be distributed to the participants either than the web links to the platform.
At the end of the workshop participants can be introduced to other European Schoolnet projects and access the resources available online for teaching in class.

Keywords: Scientix, DG Research, European Schoolnet, science education, teaching materials, community for science education in Europe, physics resources

PS.07.08.W

Strand 4: Laboratory Activities in Physics Education

Parallel Session 07.08 Workshop
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D504 (4th Floor)

Exploring plane mirrors through Lab Stations: a middle school approach

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Previous research has established specific student difficulties in dealing with image formation in plane mirrors (1-3). These difficulties, despite being very well known, often remain after instruction, specially if the teachers don't adopt pedagogical strategies devised with explicit knowledge of them. Some of the most common empirical ideas among students are:

- Images are located at the surface of the mirror;
- Image location changes if the person observing it moves;
- Plane mirrors exchange left and right;
- Images become smaller as the objects move away from the mirror.

A middle school lab session was designed to allow students to explore and understand image formation in plane mirrors. The lab session is divided into four completely independent, though related, experimental stations, each with different apparatuses / materials. Students, divided in groups of three or four, travel from station to station with a pre-defined time frame.

The stations are diversified and range from simple tasks, such as simulations or simple measurements, to tasks that involve a higher cognitive ability. At every station, in addition to experimental activities, students have to answer theoretical questions from a worksheet. The performance and sequence of the stations does not compromise the viability of the lab session.

The lab session is strongly supported by a pedagogical device - the reflect-view, a partially transparent mirror, made of semi-reflective plexiglass. With this inexpensive device, students are able to see, simultaneously, real objects and their virtual images behind the mirror.

This workshop will have three parts:

- Initially, the lab stations model will be presented. It consists of an interactive model of laboratory classes that have many advantages when compared with classical lab sessions: a reduction of the material requirements, a formative assessment, a better work flow from students, and a higher motivation. The variety of experiments and the possibility to develop different types of abilities, like conceptual and quantitative understanding of physics principles and science process abilities also contribute to the advantages of this type of sessions. Note that this type of sessions is adaptable to any syllabus. All the material can be stored in kits properly identified to facilitate the subsequent use, so teachers spend less time in preparing and storing the material.
- Students difficulties in dealing with image formation in plane mirrors will be presented and discussed.
- Teachers will be able see and perform the four experimental stations.

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Keywords: Laboratory activities, Middle and secondary school, plane mirrors, optics

PS.07.09.W
Strand 9: Teacher Professional Development
Parallel Session 07.09 Workshop
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D505 (4th Floor)

Reformed Teaching Observation (RTOP)

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Literature:
The Reformed Teaching Observation Protocol (RTOP) (Sawada, et.al.) is a 25-item rubric that provides a percentile measure of the degree and type of student-centered, constructivist, inquiry-based engagement in an instructional situation. RTOP can be used for both formative and summative classroom observations and to measure the change in instructional practice due to professional development. (Amrein-Beardsley & Osborn Popp) (Lakshmanan, et. al) RTOP scores correlate very highly with student conceptual gains. (Lawson, et.al.)(MacIsaac & Falconer)
Rationale:
This workshop is designed to introduce RTOP to all who wish to measure and possible change their teaching practice. We will score video vignettes of teaching, to learn how to use RTOP for guiding personal reflection and improvement and change of our own teaching. RTOP can be used for mentoring peers, novice teachers, and student teachers. The techniques used to facilitate interaction and discourse in the workshop can also be used with colleagues and student teachers to establish a vocabulary for discussing reformed teaching practices. This workshop is not designed to train researchers to use RTOP but could be used as an introduction to using RTOP in research.
Implementation:
In this workshop, the participants will watch and score video vignettes of teaching. The scores will be a tool to help facilitate the participants in a discussion of reformed, constructivist, inquiry –based teaching. Through the discourse, an understanding of RTOP will be developed. Each participant will receive a cd of the videos, RTOP forms, selected papers, etc.

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Keywords: Inquiry, Constructivism, Modeling, Classroom Observation, Reformed Teaching, Mentoring, Student Teaching

Strand 10: Physics Curricula
Parallel Session 07.10
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D405 (3rd Floor)

Foundation Level versus Mainstream Physics: Access for Success?

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In 1991, the Faculty of Science at the University of the Witwatersrand (Wits)established the College of Science (CoS), a credit bearing BSc Foundation Program for students who did not meet the minimum requirements for admission into the mainstream BSc 3-year degree program to access a science degree. The BSc Foundation Programme accepted students from the former socio-economically and educationally disadvantaged backgrounds. Admission into the programme was based on selection tests. The aim of CoS was to assist students to meet the new teaching and learning demands placed upon them by the University. Strydom (1991) observed that academic support or development programmes of this nature assist students to manage the transition from school to university. In 2006, the CoS was rationalised by accepting fewer students into the programme and was also renamed the BSc Extended Curriculum Programme with similar entrance criteria as the foundation program. The 2+2 model program was designed to develop language, scientific and mathematical skills, bridge course content knowledge gaps and attitudes of the underprepared students through counselling, innovative teaching and learning experience. This paper outlines the course structure, content and activities of the Physics courses both at foundation and mainstream levels with special focus on how indirect interactive instructional skills and experiential learning has impacted on the effectiveness of lectures, laboratory and tutorials learning sessions. The presentation further focuses on small group tutorial sessions' which is seen as the primary learning activity of any first year Physics course; in particular; problem solving and conceptual understanding. The value of cooperative group work in solving text-rich problems has been highlighted by Heller and Heller (1999). The guided discovery approach developed by Redish (1999) and the Technology Enabled Active Learning program designed by Belcher (2001) both highlight the importance of small group learning activities. Although at Wits we have long employed "small" group tutorial sessions which have had positive learning outcomes, we continually seek to improve the effectiveness of learning activities. Research findings will be presented that suggest changes and implementation of these teaching and learning activities have enhanced the learning of physics by the students in these courses. A direct comparison of the performance of "foundation students" who merge with new first-time mainstream undergraduate students will be compared over a seven year period.

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Keywords: BSc Foundation Programme, BSc Extended Curriculum Programme, Language, scientific, Mathematical skills, Course content knowledge, Problem solving, Conceptual understanding.

PS.07.10.b
Strand 10: Physics Curricula
Parallel Session 07.10
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D405 (3rd Floor)

Proposal for a teaching and learning sequence on cosmic rays for high school curriculum

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In general, research on curriculum innovation in physics has focused efforts in finding contents that allow the transformation of scientific knowledge into the classroom as well as the structuring of educational activities that promote the learning of topics in Modern and Contemporary Physics (MCP) by the students. These investigations are focused on ways to propose, implement and evaluate teaching and learning sequences (TLS) of specific scientific topics, while addressing research and development of teaching activities (Méheut and Psillos, 2004). Since the creation of the TLS concept many different approaches have been put forward (Andersson et al. 2005; Komorek & Duit, 2004; Leach & Scott, 2002; Lijnse, 1995; Lijnse & Klaassen, 2004; Méheut, 2004; Psillos, Tselfes, & Kariotoglou, 2004; Tiberghien, 1996). In this work, we contribute to this line of research presenting an example of TLS on cosmic rays that allows the reconstruction of the impact point and arrival direction of a cosmic particle measured by the Pierre Auger Observatory. Explaining fundamental concepts in innovative ways has been always a challenge for teachers. We present here the construction of an experiment which allows the discussion of several subjects at the high school level. The experiment is conceived in a Modern and Contemporary Physics context including discussions of Particle Physics and Astrophysics. On the other hand, the calculations involved remain in the framework of Classical Mechanics. This is one of the main features of this work which gives the teacher the opportunity to to explore Modern and Contemporary Physics concepts in an classical formulation. At the same time the experiment proposed offers an alternative route through an interesting and advanced scientific experiment, to discuss the Classical Physics principles. From an educational perspective, Astroparticle Physics is a rich field yet to be explored. The connection between macroscopic (astronomical objects) and microscopic (fundamental particles) phenomena present in this research field offers a unique opportunity to develop important scientific concepts in the learning process of high school students. The underlying pedagogical tool of this proposal is the learning by examples from the engaged construction of experiments. An important tread of the model construction proposed here is the possibility to work with scales, coordinate systems, geomagnetic orientation, time and sky maps. The possibility to work with these concepts widen the applicability of the experiment beyond the curriculum of the standard physics courses. Basic information from an event measured by the Pierre Auger Observatory is given to the students and they are guided in the construction of a model which allow the reconstruction of the direction of the first particle which entered Earth. By knowing the exact time the event was measured, the student should be able to point in a sky map from where the cosmic particle came. In summary, the analysis procedure of an event measured by the Pierre Auger Observatory goes from signal as a function of time measured by an array of detector on ground to an astronomical object in the sky. The goal of this proposal is to guide the student along this path, from the micro to the macro cosmos, discussing fundamental physics at each stopover. The experiment allowed the students to reconstruct the arrival direction of a cosmic particle measured by the Observatory using simples Classical Physics concepts. The feedback from the students and the teacher were very positive. They show that the activity has the potential to motivate the participants and that it is a valid tool to discuss the proposed subjects. A more detailed study about the results of the activity is under way, nevertheless the preliminary assessment shows that the students have been able to learn some difficult points about cosmic ray and at the same time to map a classical problem, e.g., the center of mass onto the development of the cosmic ray shower in the atmosphere. The association of ideas going from: (i) Classical to Modern Physics, (ii) subjects traditionally discussed in the classroom to measured data of a modern Observatory, (iii) microscopic structures (particles) to macroscopic scales (galaxies, the sky) is one of the features of the activity proposed here. This particular TLS proposal has already shown the viability to bring scientific knowledge to high school students.

Keywords: Modern and Contemporary Physics, Cosmic Ray, High School Curriculum

PS.07.10.c
Strand 10: Physics Curricula
Parallel Session 07.10
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D405 (3rd Floor)

Postgraduate Researchers' Experiences of Nanoscience and Nanotechnology Research- A Phenomenological Study

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With tremendous opportunities for new research, nanoscience and nanotechnology has influenced research activities in many scientific disciplines particularly physics, chemistry, biology, biotechnology, engineering and medicine. In fact, nanoscience and nanotechnology research has provided a new perspective of integrating research activities of these disciplines under common research theme. But, with the integration being very complex; disciplinary identity of nanoscience and nanotechnology remains undefined and so as the workforce needs for this research area. Therefore, whether this growing research area requires researchers that have studied specialised undergraduate or postgraduate N&N programmes; or traditional science and engineering disciplines remains under debate. Previous attempts to identify the disciplinary structure of nanoscience and nanotechnology research have focussed primarily on political, institutional and/or external factors but less attention has been paid to understand the cognitive aspects. With this background, the research is set out to achieve a critical understanding of disciplinarity associated with nanoscience and nanotechnology research and address if current education prepares the students for a PhD in nanoscience and nanotechnology research.
We selected ten postgraduate researchers form different institutes and universities in Ireland associated with nanoscience and nanotechnology research. The researchers represented a good variation in terms of their undergraduate disciplines, research experience and area of research within nanoscience and nanotechnology. Using semi structured qualitative interviews; we encouraged postgraduate researchers to describe their experiences of researching in nanoscience and nanotechnology area which eventually describe different elements of their association with nanoscience and nanotechnology research such as theoretical body of knowledge, research laboratory, experimentation, meetings, conferences and discussions but may not be limited to that. The interviews were audio recorded and transcribed for further analysis. The examination of researchers' experiences was carried out on phenomenological grounds. The examination informed us about how postgraduate researchers make sense of their world and connect their education and training to that world and understand it. We also identified if the researchers have experienced any intersection of different disciplines in nanoscience and nanotechnology research and if yes how they deal with it which explores the cognitive structures of disciplinarity associated with nanoscience and nanotechnology research.
The interview structure and questions were successful in collecting rich experiences of postgraduate researchers. The themes emerged from researchers' experiences were 'dominance of the instrumentation in nanoscience and nanotechnology research'; 'locus of interaction: instruments, meetings and conferences'; ' need of common vocabulary at workplace'; 'dynamics in nanoscience research and researchers' attitude'; 'complexities in explaining N&N research'; 'research collaborations and postgraduate researcher's participation' and 'research policies and researchers' impression'. In our paper, we present detail interview analysis around the emerged themes and discuss its implications on future research.

Keywords: nanotechnology curricula, interdisciplinary research, disciplinarity

PS.07.10.d

Strand 17: Various Topics in Physics Education

Parallel Session 07.10
Date & Time: 04.07.2012 / 10:30 - 12:00
Room: D405 (3rd Floor)

Engineering - Technological Design: students', teachers' and professional designers' ideas about learning goals

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Engineering gets more on more attention in secondary school curriculum. In the Netherlands, seven years ago, an enquiry based learning approach was started with an in meantime widespread initiative called Technasium. Main difference with regular secondary school is the subject research and design, in which students learn complex skills by working out design and research problems. For students it is difficult to learn these complex skills (Abell & Lederman, 2007), and thus for teachers to teach (de Corte, 2004). The role of the teacher in the implementation process of this new subject is important as the curriculum leaves many decisions to the teacher. In this arrangement, the picture is even more complex when is considered the role of a third party: professional designers who are supplier of the problem or design question. In case of the Technasium this can be somebody from for example a company, university or municipality. This person plays as well an additional source for making inquiries for the students and is as well one of the assessors.
In order to achieve good education in research and design, literature states that the curriculum should be contingent and congruent: expected learning goals should be traceable by teachers and students in intended as well as actual goals (Van den Akker, 2003).
The question is if this contingency and congruency is expected to be found for technological design for the practice of a good running school. Practice of the technasium, a bottom-up initiative in the Netherlands, shows that technological design is not only implemented for the skill itself, but i.e. by many seen as the panacea for creating more interest in science and technology studies.
The research question therefore is how this complicated picture of intended and final goals works out in school practice by means of a case study. We will discuss the practical contingency and congruency of learning goals for research and design.
In order to answer the research question, we used an in-depth study after the implementation process of technological design in the school. First the researcher observed the school for three months. After this, management, teachers, students and professional designers were interviewed along a semi-structured protocol. Students' ideas were also tested by paper questionnaires. Data analysis was completed by an analysis of official documents from different initiatives on technological design as well as documents from the schools. Data are analysed qualitatively, as well as by quantitative statistical analysis (if suitable).
First data show that in a school that shows good results in implementing technological design the goals as given by students very well correlate with those as given by the teachers. This indeed is a sign of good education (Van den Akker, 2003). On the other hand do these goals not necessary need to correlate one on one with those as demanded by countrywide examination programs.
A difference has been found between the initial goals and the final goals: not all final goals are tested although these goals can be found in the education program. This is contrary to what is stated by Van den Akker (2003).
The results showed as well that students think of themselves that they have a higher level of the different skills as analysed by the teachers, and even more by the professional designers. This might be seen as self-confidence as felt by the students, a positive factor in general. However, this can also be seen as an incorrect insight in one's own qualities (Bransford, Brown & Cocking, 2000).

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Keywords: Technological design, engineering, enquiry based learning, designing skill, curriculum, learning skills, learning goals

PS.08.01.a

Strand 2: Teaching Physics Concepts

Parallel Session 08.01
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D402 (3rd Floor)

The inverted classroom in a mixed-cohort introductory physics course: a case study

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In traditional, lecture-based teaching of physics, the majority of in-class lecture time is devoted to the transfer of information, with limited opportunity to promote understanding and very few instances of more demanding cognitive activity. In Bloom's well-known taxonomy of learning, typical lecture activities lie near the bottom of the cognitive pyramid. In the inverted or 'flipped' classroom model, low-level information transfer is moved out of the lectures into student self-study time, freeing up valuable contact time to promote student understanding and more cognitively taxing activities from higher up Bloom's taxonomy pyramid. Lecture activities in the inverted classroom frequently involve active learning techniques such as Peer Instruction.

Experiences with inverted classroom models are increasingly being reported, but to date they have predominantly addressed the North American context, often with particular types of student cohort, for example small physics-majors-only classes or very large introductory classes for non-specialist students (e.g. pre-med students). Here we report on the implementation of an inverted classroom approach with an introductory physics class in a research-intensive UK university. The class contains a mixed cohort of both physics major students and also non-major students studying physics as an additional subject.

We have found the inverted classroom approach to have been highly effective: gains in student conceptual understanding, as measured by the widely-used Force Concept Inventory (FCI) diagnostic are high, with a normalised gain of 0.54 and a post-course mean score of 85.4%, above the threshold for 'Newtonian mastery'. Student performance on the end of course examination (which focussed heavily on problem solving skills) was also strong and showed improvements over previous cohorts. Student feedback on the course was extremely positive, with an overwhelming majority preferring the inverted classroom approach over more traditional instruction.

The particular implementation of this course provides a case study of the successful adoption of the inverted classroom model within the context of a European research-intensive university, teaching a mixed cohort of major and non-major students. We will present in detail the implementation and outcomes of the course and discuss the implications for wider adoption of this mode of instruction.

Keywords: inverted classroom, curriculum reform, peer instruction

PS.08.01.b
Strand 2: Teaching Physics Concepts
Parallel Session 08.01
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D402 (3rd Floor)

Exploring In-Service Science Teachers' Implementation of Interdisciplinary Teaching: A Case Study

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Interdisciplinary learning places holistic applications at the centre of educational processes and offers us to construct a bridge between different disciplines for providing learners with conceptual understanding. It is anticipated that interdisciplinary teaching will help us to develop individuals' metacognitive skills and critical thinking abilities (Ivanitskaya et al., 2002).
The aim of science is to explain the universe by searching idealized, simple and delocalized qualities, and then integration of this knowledge. On the other hand, specific science disciplines (such as chemistry, physics, biology, etc…) are not enough alone to explain the natural phenomena (Donnelly, 2006, Andersen, 2007, Berlin & White, 1993, Venville et al., 2008). In addition, current reforms in education offer mainly constructivist curriculums focusing the importance of integration between science and mathematics (McGinnis & Parker, 2000, Berlin & White, 1991, 1993, Berlin, 1991) in the light of interdisciplinary learning. This situation is prevailing for all educational grades from K-4 to K-9-12.
However, interdisciplinary teaching does not contain only integration of various disciplines. It also offers connected knowing for conceptual understanding of the natural phenomena (Berlin & White, 1993). In the process of connected knowing, learners are active and try to connect their prior knowledge to new coming knowledge (Zohar, 2006, Mousley, 2004).
Skemp (1987) defined two different types of understanding, relational and instrumental. According to him, relational understanding provides learners to construct connections between concepts of a discipline and this is the real understanding. However, teachers face some difficulties while preparing tasks for providing their students to get relational understanding (Leinkin & Levav-Waynberg, 2007). As a result, interdisciplinary teaching has three components, which are integration of different disciplines, providing connected knowing and relational understanding, in this study.
Interdisciplinary teaching is an important approach for constructivist learning but it is not studied much in all level of education. There are some studies which examine integration of different disciplines (Taber, 1998, 2003, 2008; Nakipoğlu, 2003) and they examine undergraduate students. There is a study which examines biology teachers' views about interdisciplinary teaching (Dervisoğlu & Soran, 2003). There is a big gap in the literature about interdisciplinary teaching approach in all level and in all subjects. This study will examine application of interdisciplinary teaching in a physics topic (electromagnets), at eight grade with in-service science teachers with a case study. It should not be always possible to observe real phenomena with interviews or surveys. Peoples sometimes talk about what they want to behave than how they behave. But video recording shows what is exactly going on.
We want to make an in depth analysis about how teachers apply interdisciplinary teaching in their classes in a specific physics topic. In this respct, the most proper research design is the case study. First of all teachers, whom observations were realized, were determined by convenience sampling. There are four science teachers, one of them was in a small town connected to Kahramanmaraş and three of them were in center of Bursa. They were informed about the study and participated voluntarily. One of them, who was living in Kahramanmaraş, had three years of professional experience and others had working experience more than five years. Observations were done at class hours in which electromagnetism were thought. It holds two class hours approximately 80 minutes. Students were at 8th grade and there were approximately 35 students at each class. This case study was conducted in an interpretivist perspective based on video recordings. During the video recordings the researcher did not participated in the classroom. This was preferred not to disturb the natural environment of the classroom.
Before video recording, possible codes were determined from the related literature. Then, video records were transcribed, and read repeatedly to find and construct codes. At each reading codes were adjusted. After four teachers transcriptions have been read, a coding list was finalized. All transcriptions were read again based on new coding list. Each transcription coded by each researcher and there were about 85% consistency at codings. Codes were appointed to the most meaningful parts of the data. Then, the codes were arranged and clustered. Next, themes of the study were extracted from the clustered codes. Finally, themes were defined operationally for providing the results meaningful to other researchers.
Interdisciplinary teaching had three components in this paper. These components, which were integration of different disciplines, providing connected knowing and relational understanding, were extracted from the scientific literature. Only one of the participated teachers applies interdisciplinary teaching and only the component of providing connected knowing. Connectedness within the subject was provided in the classroom. For example, one of the participant teachers used students' knowledge related to frictional force while teaching electromagnets on the example of super-sonic trains. Students' prior conceptions about electricity and magnets were connected to the new concept, electromagnetism. These prior conceptions also included daily life and real life examples of the students.

From the codes and themes we can conclude that even they are science and technology teachers, that is they were thought on both physics, chemistry and biology they could not mainly use interdisciplinary teaching. Why they could not apply interdisciplinary teaching should be because of it is a physics topic. They should thought that it is hard to this for physics and physics is a separate science subject. For enhancing power of the study results, there should be interviews about science teachers’ views about all aspects of interdisciplinary teaching.

Keywords: interdisciplinary teaching, science education

PS.08.01.c

Strand 2: Teaching Physics Concepts

Parallel Session 08.01

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D402 (3rd Floor)

Understanding rainbow at the pre-university level

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In the paper generation of the rainbow is explained at the level that should be comprehensible to pre-university students. The crucial point for the students to adopt the explanation is a carefully performed demonstration experiment, which shows the students that the light refracted at particular angle upon shining on a spherical "drop" of water is much brighter than the light refracted at other angles. All one needs to perform the experiment at school is a laser pointer and a spherical or a cylindrical vessel with thin transparent glass walls.

At the beginning of the presentation typical characteristics of the rainbow are summarised with the emphases on the things that can be observed by the students and requires no particular mathematical skills and just the basic knowledge of physics, typically obtained after the first year of physics classes at the age of around 14 or 15. Some of these characteristics are: one or two rainbows can be seen at the same time, each having different order of colours; a rainbow typically appears, while it is raining, but there is the Sun behind our back and some clouds (i.e. water droplets) in the sky, where the rainbow appears to be; the rainbow bow is circular, i.e., it is a part of a circle; the inner and brighter rainbow is red on the outside edge and blue at the inside edge.

The core of the presentation is the experiment, done with the laser pointer and the glass vessel, filled with water. The students should be observing the spreading of the laser dot, exiting the vessel after one internal reflection, because this type of light contributes light in the rainbow (Adams, 2002). The teacher is changing the offset, at which the laser beam hits the vessel surface. First the vessel is hit in the direction of its centre and next the laser pointer is slowly shifted outwards and the students are observing the size of the refracted laser spot. The refraction angle is slowly decreasing from 180° as the offset is growing. At the same time the size of the refracted laser spot is spreading from a small dot at the beginning. At first the offset is changed relatively fast in order to make the students see the corresponding change of the refraction angle. It is decreasing until the offset of the incident laser beam is approximately 0.85 of the radius of the vessel. Here it reaches the minimum and starts to grow as the offset is increased beyond 0.85 of the vessel radius. It is important to point out this minimal refraction angle to the students. Next the change of the offset from zero up to the vessel radius is repeated slowly and the attention is turned to the size of the exiting light beam, i.e., the size of the spot the refracted light makes. Around the minimal refraction angle the refracted light beam narrows significantly and at the same time the refracted laser spot becomes very bright. This is the light that we see as coming from the rainbow, if enough water droplets are just at the right place relative to our standing point and the position of the Sun. Because of the slightly different refractive indices of different wavelengths of visible light in the water, each wavelength (i.e., each colour) is refracted at a slightly different angle. With the Sun shining onto sufficient water droplets in the right parts of the sky the rainbow is seen by a suitably standing observer.

At the end of the presentation a few particularities regarding the rainbows are explained, relating the explanation to the above written rainbow formation, for example, the fact that the rainbow does not change its "size" as we move closer to it. By closing the lesson this way the students on one hand see and appreciate the power of understanding how the rainbow is generated and on the other hand improve their memory of the whole derivation by connecting the impressive rainbow property that it is always of the same size with the explanation of how the rainbow is generated.

Reference Adams, J.A. (2002). The mathematical physics of rainbows and glories. Phys. Rep. 356, 229-365.

Keywords: rainbow, demonstration experiment, geometrical optics

PS.08.01.d

Strand 2: Teaching Physics Concepts

Parallel Session 08.01
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D402 (3rd Floor)

Knitting patterns and the concept of anisotropy

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Material properties are anisotropic when they depend on a direction of the applied external stimulus. Although anisotropy presents a concept that is rarely discussed at the university level and almost never at the pre-university level, it is not far from everyday life experiences – walking on a busy street, moving in a highway etc. Even more, several devices, which are used everyday almost constantly, are based on the anisotropic properties of liquid crystals – flat screens, mobile phones etc. Therefore it seems reasonable to introduce the concept of anisotropy, on the conceptual level at least, even to younger students. Making them aware of the anisotropy in properties, as students they could later develop more thorough comprehension of this difficult concept. An introduction of any new concept in physics is more successful if a knowledge and understanding could be built on experiences. Although anisotropy is not considered as a good example of such a topic, we present a simple model, which can provide experiences that are later used for development of the conceptual understanding.

Any person ever wearing a cotton T shirt or a woollen pullover knows that the clothes lose their initial shape after wearing and washing. They usually extend or shrink in one direction more than in another. The difference in extension depends dramatically on the material and on the knitting pattern. This last dependence we use for a demonstration of the concept of anisotropy.

Several different knitting patterns were prepared. As they are extensible, an elastic coefficient if the force is applied in different directions is easily measured. Such measurements show straightforwardly that

a) The magnitude of elastic coefficient depends on the direction of the applied force
b) The direction of the extension of the pattern is not always parallel to the applied force
c) There exist only two directions of applied force to which the extension is strictly parallel to the applied force
d) This two directions coincide with the directions of applied force for which the elastic coefficient have and extreme (either the minimal or the maximal) value
e) The pattern significantly influences the elastic coefficients in general

How are these results related to anisotropic properties in general? The knitted pattern is an example of an essentially 2 dimensional object, because it is not possible to knit the structure into the third dimension. One can therefore expect a difference in behaviour in two directions only (a) - it models uniaxial anisotropic materials which have only two different directions for which the external stimulus and the response have the same direction – two eigen direction only (c and d). Next, we will show that angular dependence of the elastic coefficient is exactly the same as the angular dependence of an extraordinary refraction index in a uniaxial crystal (b). It is also extremely difficult to visualize the non-parallelism between a reason and a consequence for anisotropic materials valid for a general direction of applied stimulus (b). Finally, using the same material and different patterns it is very easy to show that the main reason for anisotropy is hidden in the structure and usually not in chemical properties of the constituent molecules.

Keywords: anisotropy, elastic coefficient, refraction index

PS.08.02.a

Strand 3: Learning Physics Concepts

Parallel Session 08.02
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D403 (3rd Floor)

Investigating students understanding on the concepts of electromotive force and its differentiation from potential difference in electromagnetism

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The general theoretical framework for research into alternative conceptions, proposing that prior knowledge and students' conceptions interfere and affect their learning in new contexts, has been used extensively in the literature. The need for information on students' alternative conceptions and forms of reasoning is particularly necessary in areas of the curriculum that have barely been researched due to their type of contents or the level of teaching. Although the concept of electromotive force is necessary to explain the energy balance in direct current circuits and to analyze situations involving the phenomenon of electromagnetic induction, it has been given little attention in the research literature on teaching and learning electromagnetism.
To research students' understanding on emf and its differentiation from the potential difference concept, a questionnaire was designed with three questions, one in the context of direct current circuits and the other two within the context of the phenomenon of electromagnetic induction. The questions are open so that the students have the chance to argue and justify their statements. The questionnaire was given to engineering and physics students from Spain, Colombia, Belgium and Ireland, after they had studied the subject in class. Student answers were analysed following three strategies: 1) Coding the frequency with which certain ideas or topics appear; 2) Noting the patterns that come out of these ideas or causal explanations; 3) Grouping the explanations into descriptive categories. The category grouping used previous results from research into students' alternative ideas on electricity. The focus was on the students' understanding, taking the students' answer as a whole, rather than focussing on the occurrence of particular statements corresponding to a specific category description.
The results obtained in the four countries will be presented and compared in the oral presentation. We have found that students in introductory courses can build a functional understanding of emf and pd, but their understanding appears to falter when they have to differentiate between them, as emf is often given the same properties as potential difference. Students' difficulties seem to be strongly linked to the absence of analysis on the work carried out on the circuit and its energy balance.

Keywords: Learning electromotive force concept, introductory physics courses, electromagnetism, alternative conceptions

PS.08.02.b

Strand 3: Learning Physics Concepts

Parallel Session 08.02

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D403 (3rd Floor)

How Do The Use of Gowin's V and ICTS Effect Student Learning in The Construction of Free Body Diagrams?

Gabriel Castro Ronquillo, Alexander Ortega Medina
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The purpose of this study was to determine the effects of applying the technique of Gowin's V and the use of information and communication technology (ICT) in the performance of students in the unit of dynamic development of the diagram free body. For this purpose we used a sample of 120 students enrolled in an introductory course in physics, pursuing careers in engineering by organizing four groups: two experimental and two control groups. One group received Instruction Gowin's V and use of ICT, while the control groups did not receive any instructions. However, all groups received the same content. Students of the four groups yielded a test of knowledge input and output knowledge test, a cloze test, as they take the test Felder – Silverman. We developed guiding problems with the technique of Gowin's V, to assist in the instructional process in the particle dynamics unit, enhanced by the use of ICTs. To test the research problem, how it affects the performance of students using Gowin's V when applied in the construction of free-body diagrams for troubleshooting particle dynamics? We used the ANOVA F test with 0.05 significance level.

This study tested the hypothesis that students who applied Gowin's V and use of ICTs for free-body diagrams in the particle dynamics unit within inertial systems. It was found that the instructional group performed better than the experimental group.

The preparatory courses are designed to leverage the knowledge and skills to develop conceptual understanding and development of problems in high school, thus promoting the teaching - learning. Physics is not just a theoretical science; it is also an experimental science. Like all sciences, seeking that its findings can be verified by experiment and theory can make predictions for future experiments. Given the extensive field of study of physics, it is regarded as a fundamental science.

Keywords: Gowin's V, ICT, free-body diagram, particle dynamics

PS.08.02.c

Strand 4: Laboratory Activities in Physics Education

Parallel Session 08.02

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D403 (3rd Floor)

Educational use of data from the CMS experiment at the LHC

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The Interactions in Understanding the Universe collaboration (I2U2) aims to bring cutting-edge, hands-on physics to students (typically between 16-18 years of age). We have created three e-Labs—web-based, student-led and teacher-guided explorations of datasets from professional experiments. These include CERN's Compact Muon Solenoid (CMS) and the Laser Interferometer Gravitational-Wave Observatory (LIGO). Students can also explore data from a network of classroom cosmic ray detectors. Ranging from short analyses (several class periods) to longer projects that students work throughout a term, e-Labs can be adapted for use in classrooms, science clubs or other after-school activities.

I2U2 e-Labs provide milestones that guide students through their own research project. These assist the students as they pose a research question, explore the data and share results. The e-Labs also provide data visualization and analysis tools, options to download data to a local machine, student logbooks and a facility to store, view and comment on plots.

I focus here on the CMS e-Lab. In the e-Lab students can learn about how physicists analyze data, about detectors, and about fundamental particle physics. For example, students exploring the CMS e-Lab can analyze the inematic properties of stable particles - the ones seen in the detector - to understand basic properties of the unstable parent particles that produced them and thus deepen the student's knowledge of the fundamental building blocks of our Universe.

The datasets used in the CMS e-Lab have been made available to the public by the CMS collaboration for educational and outreach purposes. These proton-proton collision data produced by the Large Hadron Collider at CERN include more than 300k events containing pairs of electrons, muons and jets as well as W and Z bosons. The data are prepared and published in an open, extensible, text-based format.

The CMS datasets are also used in international educational programs in Europe, the United States and the rest of the world such as the International Particle Physics Outreach Group (IPPOG) masterclasses and QuarkNet. The open nature of the data and the tools provided allow for open and independent study of real LHC data to allow everyone with a passion for physics to share the excitement of the world's largest science project.

I describe the current status of these activities, the positive feedback from the students, and the bright future outlook, including the potential to broaden these activities to a wider range of audiences.

Keywords: Large Hadron Collider, high-energy physics, public data, online educational tools

PS.08.02.d

Strand 3: Learning Physics Concepts

Parallel Session 08.02
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D403 (3rd Floor)

How high school's students understand Electricity and Magnetism?

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Electricity and Magnetism is one of topics at Czech high school's physics. It is natural to explore how our students understand concepts from this area.
At first, we used Conceptual Survey of Electricity and Magnetism (CSEM) [1]. CSEM test is intended for students of introductory physics courses at universities so we had to short it – we left out questions about topics that are not taught at Czech high schools. Final test has 22 questions (instead of 32 questions in the original test). All conceptual areas from the original CSEM test remained except of the area concerning Induced charge and electric field.
We used this test as a pretest for more than 150 high school's students and as a posttest for nearly 250 high school's students. Overall result for the pretest was 22% and for the posttest 27%. We can compare this result with results of the pretest of American introductory students: 25% (for Algebra-based courses) and 31% (for Calculus-based courses). Of course, it should be considered that our test was shortened and few questions were left out.
Some interesting outcomes of this test will be presented. The main finding is that this test is too difficult for our high school's students. To explore their understanding of electricity and magnetism concepts we need a simpler test. One hypothesis (which follows from results of the current test) is that some assignments and pictures are overly abstract for students and students don’t understand them. So, one goal for the new test is to make assignments more concrete and comprehensible.
This new test is now prepared and will be presented on conference. Results gained from this test and their interpretations will be presented, too.
We plan to provide the new test as a diagnostic tool mainly for Czech physics teachers, but the English version of this test could be provided too.

[1] D. P. Maloney, T. L. O´Kuma, C. J. Hieggelke and A. Van Heuvelen, “Surveying students´ conceptual knowledge of electricity and magnetism”, Am. J. Phys. 69, 12-23 (2001)

Keywords: Electricity and Magnetism, concepts, survey, high´s school education, CSEM

PS.08.02.e

Strand 3: Learning Physics Concepts

Parallel Session 08.02

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D403 (3rd Floor)

Tablet based interactive GPS textbook – a new kind of an educational means

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Tablet base interactive textbook explaining GPS principles will be presented.
Explanation will be presented at the secondary school level, without using differential calculus, using only the vector calculus (scalar and vector product, basic equations used for solving vector equations). From physics, both Special and General Theories of Relativity are mentioned and their use explained. Namely, following the Special Theory of Relativity, the frequency of moving object is slightly, but remarkably lower than frequency of the clock staying in rest, whereas – in the opposite – following General Theory of Relativity, frequency of a clock staying in a weaker gravitational field (22 000 km from the Earth) becomes to be higher than those of the clock staying on the Earth. In a given example of GPS system, effect of the General Theory of Relativity is stronger than the contribution of the Special Theory of Relativity. Those effects are estimated only and presented as a given facts, among other verifying nay moment in evedyday's life both relativistic theories. In the opposite, the geometrical construction of the unknown position by cros/section of three spheres is discussed and explained in details to show the utility of general geometry. The more, some simulations are provided for the learner for the self/use of the numerical approximation to find an optimal solution in a realistic case when the received data are not prefect.
The presentation is an example of an everydays life „magic“ device and use of their powerful properties in teaching and learning. The new technology brought the new possibilities compared to the classical books or notebooks, namely transferability, interactivity, flexibility, web connection.
A complex cooperation of specialists in science (topics), programing (model, animation), pedagogy (scenario), fine arts (illustration and movies) with modern technology (animation, graphics) needed a multi-disciplinary cooperation and represents a particular cultural aspect.
This program will be presented on a tablet and in English. However, for the use on the secondary school, mutations in mother-tong-languages are more recommended (the Czech one was prepared simultaneously and is now ready, too).

Keywords: interactive textbook, tablet, GPS principle at secondary school level, multimedia

PS.08.03.a

Strand 4: Laboratory Activities in Physics Education

Parallel Session 08.03

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D404 (3rd Floor)

Learning in the physics laboratory as a material discursive practice

Jonte Bernhard
Linköping University

According to Alfred North Whitehead (1963): "The reason we are on a higher imaginative level [in modern science] is not because we have a finer imagination, but because we have better instruments." Despite Whiteheads statement I argue in this paper that the role of experimental technologies for student cognition and learning in laboratory is a neglected aspect in physics and science education research. Laboratory-learning activities is commonly described as "direct experience with physical phenomena" (Trumper, 2003) and in a similar vein the National Research Councils' America's Lab Report (Singer, Hilton, & Schweingruber, 2006) as "opportunities for students to interact directly with the material world." Laboratory equipment is seen as something that is just "manipulated" (e.g. Lunetta, Hofstein, & Clough, 2007) and observation in the laboratory is seen as unproblematic requiring only low level of cognition. This is in line with the "[traditional belief] that … instruments and experimental devices … per se … has no cognitive value" (Lelas, 1993). Popper (1972), for an example, restricted his epistemology to the "world of language, of conjectures, theories, and arguments".

A consequence of this is that emphasis in research is placed mainly on instructions, concepts, and ideas or on organization of labs and the role of instrumental technologies for student learning in laboratories are rarely studied and their role is usually either neglected or taken-for-granted (Bernhard, 2012; Ihde, 1991). In 1958 Niels Bohr suggested that we should use the word "phenomenon exclusively to refer to the observations obtained under specified circumstances, including an account of the whole experimental arrangement" and he also argued that "it is … impossible to distinguish sharply between the phenomena themselves and their conscious perception" (Bohr, 1958). Agencies of observation (the technology) and the object studied (some aspect of the world) cannot meaningfully be separated in Bohr's view. Following Bohr I argue that phenomenon possibly for students' to perceive, and hence what is possible to learn, is related to the technologies (artefacts) used for collecting and re-present experimental data. The instrumental technologies used places some aspects of reality in the foreground, others in the background, and makes certain aspects visible that would otherwise be invisible ("Instrumental realism", Ihde, 1991).

As an example of this I will present a study of students' attempts to make sense of accelerated motion of an object on an inclined plane. Activities in three different experimental setups (probe-ware/MBL, photo-gates and tape-timer) that are commonly used in upper secondary school physics were recorded by video. My analysis shows that the different technologies used indeed have different affordances for students' perception of different aspects of the motion. Hence, for the students' the same phenomenon does not appear, although on the surface the "same physics" is studied. Furthermore it is well known from prior research that it is difficult for most students to discern and learn motion concepts such as velocity and acceleration and my results show that some of these difficulties cannot be addressed using some of the common technologies.

As a conclusion I argue that the role of instrumental technologies used in labs for student learning cannot be neglected and that students' courses of action in labs should be seen as a material-discursive practice (Barad, 2007).

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Keywords: Laboratory learning, probe-ware, technologies, artefact mediation, material-discursive practice.

PS.08.03.b

Strand 4: Laboratory Activities in Physics Education

Parallel Session 08.03

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D404 (3rd Floor)

A novel approach to encourage students' independent thinking in the physics laboratory

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The objectives of physics laboratory courses include fostering conceptual understanding and development of several important cognitive, psycho-motor, attitudinal and affective abilities1. It is no exaggeration to state that the teaching and learning of physics is inadequate unless students gain a significant 'hands-on-minds-on' experience in experimental physics through well-thought laboratory training. In most of Indian colleges and universities, (and probably at many other places) the usual practice of performing a set of experiments, in a 'cookbook' mode, hardly help students achieve the objectives of the physics laboratory courses. A need was felt to develop novel approaches which will encourage students active participation, independent thinking and offer an opportunity to learn 'how to think scientifically' during traditional physics laboratory courses without major curriculum and 'content' changes2. This paper describes the details of an instructional approach designed and being followed by the author for past few years, to encourage students' independent thinking in the physics laboratory.

Here, 'guided problem solving' approach is adopted by combining 'problem-solving' and 'guided design' modes of instruction. In this approach an experiment is presented as an 'experimental problem' with guiding procedural instructions. During a typical laboratory session, first an introductory demonstration is presented to each group separately by the mentors for 20 minutes as a prelude to the problem and then rest of the time is made available for students to independently 'solve' the experimental problem. The demonstration is carefully designed to help students to solve the given experimental problem by introducing either, the basic conceptual understanding required for the problem, the experimental method or technique or the experimental arrangement. Each demonstration, which is designed to have a smooth flow of activities, questions, answers, discussion and explanations, is presented in an interactive manner and the interaction between the students and the mentor is triggered through observations, questions and related discussion. Each demonstration is presented to stimulate thinking in students and develop cognitive abilities like observing, application, synthesis, interpreting and inferring.

In this approach, an experimental problem is not presented as a single, monolithic unit, but instead presented as a sequence of interrelated subsections, each subsection being a small activity, through which the students are stepwise guided to the complete solution. Thus, they solve the experimental problem in graded stages. Each subsection/stage may have a different focus, may involve a different type of experimental activities and may aim at different learning outcomes. Students are expected to work independently with a minimum of guidance from the mentor, but they are 'guided' in graded stages through a carefully written student handout for each experimental problem. In the handout, students are given 'open' procedural instructions to think of and design their own method, perform measurements, collect and analyze data and thus 'solve' the experimental problem. These instructions guide students' on possible way to solve the problem and at the same time offer a room for their independent thinking, designing and planning of actual procedures. These instructions run like, "You may have to use law of Malus; plot an appropriate graph to determine Z; record the necessary data to study the inter-dependence of X and Y; determine the value of X graphically". Here, the emphasis is on students' own thinking and planning, on moving them away from 'cookbook' instructions, from spoon-feeding.

Finally, the approach will be illustrated by describing a set of experimental problems and the demonstrations with some details of the 'problem' and experimental arrangement, being used by the author for training of students and teachers at the introductory university level.3

Keywords: Physics laboratory courses, training in experimental physics, scientific thinking, guided problem solving, experimental problem, demonstration, procedural instructions

PS.08.03.c
Strand 4: Laboratory Activities in Physics Education
Parallel Session 08.03
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D404 (3rd Floor)

Beyond recipe-based practical exercises: towards a better future?

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Traditional "recipe-based" practical exercises may have a high degree of 'outcome predictability', but, because they absolve the student of a great deal of thinking, they arguably have a low degree of value as learning experiences and hence they fall short of achieving the goals of laboratory programmes. Practical exercises could be improved by becoming problem-solving exercises, where the student is given prior warning only of the broad outcome of the task and must devise a method as well as generate an answer to a question. The student is confronted with a collection of apparatus and must figure out how to use it to perform the specified task.
A common objection to this sort of exercise is that, realistically, they can only be performed by students after – and preferably soon after - the relevant theory has been 'covered'. Also, all students in a given group would, by preference if not of necessity, have to perform the same exercise simultaneously. This could present a difficulty for service courses where large groups of students must often be catered for, and logistic and economic factors become an issue. Where this is the case, practical exercises are usually performed in rotation to avoid having to purchase and store expensive apparatus in large quantities. As a result, the practical and theoretical parts of the curriculum become almost entirely independent of each other as the practical exercises being performed at any given time are mostly not linked to the theory then being covered. Hence, economic and logistic obstacles are allowed to impact negatively on the educational value of the curriculum.
In this presentation we suggest that practical exercises do exist that constitute good learning experiences and which can easily be performed by first year students without detailed procedural instructions, introducing an element of problem-solving which is usually neglected in practical programmes. Also, the apparatus for these exercises is both cheap to obtain and compact - and thus relatively easy to store - hence the logistic objections mentioned above become invalid.
One such exercise requires the student to determine the track separation of a compact disk using a laser pointer. Both foundation-level engineering students and student teachers have successfully performed this exercise without recipe-style instructions. Exercises of this type have been shown to have a better didactic impact on students than the traditional, recipe-based practical exercises common in introductory physics courses.

Keywords: Practical exercises, problem solving,

PS.08.03.d

Strand 4: Laboratory Activities in Physics Education

Parallel Session 08.03

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D404 (3rd Floor)

Enhancing student learning by modifying first-year university physics laboratory experiments through peer review

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The role of laboratory experiences in science classes has long been recognised as an important component in student learning. However, to provide meaningful learning experiences, laboratory activities must be interesting, stimulating and motivating, engaging, and promote inquiry based and higher order thinking. In order to achieve this aim, colleagues from various Australian universities have developed a methodology known as "ASELL" (Advancing Science by Enhancing Learning in the Laboratory [1] with a focus on laboratory activities in chemistry, physics and biology.

One of the principal aims of ASELL, is to: "make available, via a database, materials relating to undergraduate science experiments which are educationally sound and have been evaluated by both students and academic staff. These materials consist of everything needed to introduce the experiment into another institution, as well as evaluation data relating to both the discipline and the educational aspects of the experiment" [1]

An interdisciplinary team at Curtin University has adopted the ASELL methodology to improve chemistry and physics laboratory experiments. This presentation will focus on improvements to student learning in physics laboratories, and how they were achieved, using the ASELL framework.

The process of improvement (an "Action Research Cycle") consisted of the following steps:

1. Survey students to collect their feedback about the existing laboratory experiments and thus establish a baseline.
2. Based on the students' feedback, identify and improve those experiments which fell below the ASELL acceptance criteria.
3. Take these experiments to an ASELL national Workshop [2], where the experiments are evaluated by a group of academics and students from other universities.
4. Based on feedback from the participants of ASELL Workshop, further modify these experiments.
5. Survey students once again. Analyse the data to see if ASELL acceptance criteria has been achieved. Improve the experiment if needed.

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Keywords: physics laboratory, ASELL Framework, student learning

PS.08.04.a

Strand 6: Secondary School Physics

Parallel Session 08.04
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D405 (3rd Floor)

Students' strategies in solving physics problems – questionnaire research

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The problem solving in physics has a long tradition in the Czech high school education system, which is proved, among others, by a large number of problems in physics textbooks and problem collections (e.g. [1], [2]). Regrettably, many students solve the tasks without deeper understanding of the physics context and the solving often turns into simple "mathematical manipulation" with formulas. It is important to establish the cause of these difficulties and to try to mitigate them.
Therefore, we have prepared questionnaire for high school students and teachers. The aim of the survey was to find out if students use any approved steps that help them with the problem solving. Another goal for the research was to gain students' opinion about the importance of the problem solving.
Two questionnaires for students were composed – one containing open format questions and the second with open format questions as well as rating scale questions (use of chosen problem solving strategies). The teacher's questionnaire has only open format questions. The dividing of the students' strategies is partly inspired by a research described in the article [3]. The participants of this questionnaire survey are high school students in the last four classes (students at the age of 15 to 20), who are attending physics lessons during their study, and their teachers.
The questionnaire study is first part of a more extensive qualitative research concerned with the problem solving in physics education. Next parts, for example creation and testing of methodical materials, will follow afterwards.
In our contribution we will present results and methodology of the described research. Based upon the results of the study we will also show the steps that students, according to their own opinion, use in the process of problem solving and the connection between these steps and students' age and marks in physics.

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Keywords: Problem solving strategies, Secondary school education, Physics

PS.08.04.b

Strand 6: Secondary School Physics

Parallel Session 08.04
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D405 (3rd Floor)

The Establish project and an assessment of its impact on students

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Charles university in prague

The paper deals with the European project Establish (has received funding from the European Community's Seventh Programme [FP7/2007-2013] under grant agreement no. 244749), which supports inquiry based science education (IBSE). Particularly, the article is focused on an assessment of an impact of the project on students. The assessment is provided in the areas of: intrinsic motivation, development on students' cognitive skills, appreciation of the importance of science and technology in society, and students' inclination toward taking up careers in science. For collecting evidence two questionnaires will be used. The first one is based on Intrinsic Motivation Survey and it is aimed at assessing students´ interests, their perceived choice and usefulness of implemented learning units. Each learning unit consists of several lessons which are designed within the project. The questionnaire is aimed at collecting feedback after each learning unit. The second questionnaire assesses impact on the project's impact on students' attitudes toward science and technology and on their knowledge about nature of building up science knowledge. The questionnaire consists of two independent parts: adopted a part of the ROSE (The Relevance of Science Education) questionnaire and the Epistemological Beliefs Assessment for Physical Science. This questionnaire is intended for collecting data from students who completed at least three learning units. In the article, results of a pilot study are presented. Particularly, we discuss reliability and validity of the tools. Because of translations of tools into native languages of participated students, we pay lot of attention to the discussion of the content validity. Around one hundred students per a country have participated in the pilot study. After carrying out the pilot study, final versions of questionnaires will be available in several European national languages. Then the tools can be used not only for the purpose of the project, but also in the common school practice.

Keywords: inquiry based education, establish, secondary education, feedback, impact

PS.08.04.c

Strand 6: Secondary School Physics

Parallel Session 08.04

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D405 (3rd Floor)

From physics textbooks to Physics teaching packages: New experience in teaching physics in Iranian school

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It has been years teachers in grades 9 -12 in Iranian schools are planning their curriculum (lesson plan) solely based on the text book written for each semester, and just follow it. It has also been a decade that Physics teachers are being trained to change their teaching techniques from traditional and teacher-centered learning methods to student- centered learning strategies. Furthermore, there has been good effort to alter the quality of the Physics books to include experiments, particularly the ones that could be tried by very available and cheap items (hands on activities). In this regard, there were also many workshops for Physics teachers to become familiar with these experiments. In spite of all these efforts, assessments show that most students, who study Physics through their school years, gain better understanding of the physics principles rather than their applications in various situations. For example results from assessments clarifies that most of the students can successfully explain Newton Laws and Conservation Law while very few of them can properly employ these laws in various situations, including solving physics problems.

These not so fulfilling results from teaching techniques in different levels in high schools in Iran, has resulted in major planning to adjust content of books as well as teacher's education. In the first phase of this new plan just a small sample group comprised of some students as well as their teachers were included. Physics packages were planned and developed to replace books. Student's package included a textbook, a workbook and interactive software. Teacher's package contained a guide book and supporting software that were provided to them after necessary training. Accumulated feedback during the past couple of years proves joy and pleasure of learning has come into classrooms and students show much desire to be involved in classroom activities. Teachers also welcome this new technique and hope it would be applied to other Physics textbooks too.

Keywords: physics textbook, teacher traning, Physics teaching packages

PS.08.04.d

Strand 6: Secondary School Physics

Parallel Session 08.04

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D405 (3rd Floor)

Physics Pedagogy and Assessment in Secondary Schools in the United States

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Physics education has undergone major changes around the world. Pedagogy, the use of technology and assessment have become important areas of study. The goals of physics education research are uniform internationally with the hopeful outcome that we help students better understand physics and its role in world development. Much of the progress in physics education research has been made at the tertiary education level, while much work is to be done at the secondary level. The secondary level is important as a preparation for the advanced training in science and knowledge for the general public. The aim of our research is to learn what physics teachers in secondary education are doing in and out of the classroom to best educate the type of students they teach. By studying the various approaches used by physics teachers in different situations, we hope to be able to make recommendations on what pedagogy and assessment tools are effective for different student populations.

Our research studies the differences in pedagogy in secondary school physics courses with regard to location, school type and student populations. By learning what approaches work for these different populations, we can make recommendations for secondary school physics teachers in similar situations. We have distributed a survey to secondary school teachers in the USA, collecting data on demographics, student backgrounds, physics teaching methods and assessment techniques. This data was used to study the pedagogical approaches that teachers use for urban, suburban and rural areas in the USA.

We discovered differences in pedagogy in the three geographical areas, corresponding to the background and nature of the students in those schools. I will outline key results on the pedagogical approaches that most effectively enable secondary school students in these demographic areas to learn physics and address the assessment techniques used to test their effectiveness.

Keywords: Secondary, pedagogy, assessment

PS.08.05.a
Strand 7: University Physics
Parallel Session 08.05
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D501 (4th Floor)

Friends, footholds, and fear: impacts on physics learning (Part 1)

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Over the past several years, the University of Cape Town (UCT) and Oregon State University (OSU) have been collaborating on a number of research projects all with a central theme of understanding learning affordances. This work, combined with other research, has led us toward developing a generalizable cognitive framework that can be used to develop research-based curricular materials. The key concept is centered around the notion of what we have termed the "idea space", using a geometrical metaphor to describe the interplay between two components that operate at the cognitive level, namely the available (and maximally limited) working memory and the network of cognitive resources that are primed for potential use. We posit that the quality of engagement with a question is related to the size of this space. Thus, if students end up having a large 'idea space' when approaching a learning task more meaningful engagement will take place. Conversely, if a small idea space is created as a result of either compromising available working memory and / or because of a weak network of resources at hand, engagement with the task will be of low quality. For example, one way in which working memory can be compromised is through off-task monitoring. The priming of a larger or smaller network of resources depends on the way in which questions are posed to the students. An example of how different question types would activate different idea spaces follow. Consider the question, "Will air resistance affect the motion of the object?" as opposed to the question "Make a list of all the possible factors that you consider could affect the motion of the object and next to each write down if you think it will have a large or small effect." The former question puts a student in the frame of recalling authoritative information and being either correct or incorrect with only two possible choices: yes or no. The latter question "opens the idea space" and allows the student freedom to express understanding about multiple aspects of Newton's second law without being limited. Some questions and ways of posing questions potentially activate monitoring functions that use up working memory that could otherwise be used for productive resources. In the above example, expecting a student to give a yes or no answer dictates that they are either correct or incorrect. This could induce fear on the part of an unconfident student, which activates monitoring functions that take up needed working memory. A classic example of monitoring is that of stereotype threat. Research indicates that stereotype threat uses up working memory that crowds out space for problem solving, leading to lower scores for those who fear they will be judged as a stereotype. Thus, fear in general leads to a reduction of the idea space. We discuss the data the underpins the idea space model in Part 2 of the presentation

Keywords: cognition, learning physics,cognitive model

PS.08.05.b

Strand 7: University Physics

Parallel Session 08.05

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D501 (4th Floor)

Friends, footholds, and fear: impacts on physics learning (Part 2)

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“Friends, footholds, and fear” refers to three key aspects of a cognitive model, the “idea space” (described in Part 1 of the presentation) that can be used as a simple framework for generating and evaluating teaching materials. In short, the bigger the idea space the higher the quality of student engagement. Here we discuss three sets of data that underpinned the development of the model to illustrate their influence on student engagement in the physics classroom.

“Friends” and the impact of perceived audience: In this study students were provided with a worksheet (part of a research instrument) requesting them to report what they had measured during a laboratory experiment that involved scattered data. Three different audiences were posited to each student: the instructor, a friend and a written laboratory report. The most interesting finding was that 74% of the sample in question (#N= 120) answered the same question differently to at least one of the audiences, with 24% answering differently for all three audiences. Even more telling was that fact that the instructor audience was provided with the least acceptable answers in a majority of instances. The main implication is that the perceived audience which follows (usually unconsciously) from the way in which we pose questions impacts the idea space. This was further substantiated in follow up interviews. Thus, posing the question in a way that allowed the student to be the “relative authority” tended to produce more acceptable answers as opposed to questions that were posed by an authority figure and carrying an implied judged for correctness. From the perspective of our model it would appear that in the latter case the idea space is reduced through activating monitoring functions in working memory.

“Footholds” for understanding and conceptual metaphor. The results summarized here come from a study of students’ ideas of density using cognitive linguistics as an interpretative tool. In particular, the study aimed to identify whether any particular ”foothold metaphors”, if any, were more productive than others in promoting a deeper understanding of density in its broader applications. In this study students were asked to explain “density” and/ or “denseness” in words and then to draw an explanatory diagram (to an audience that allowed the student to be the relative authority). This was followed by a question that asked students to predict the equation for “charge density, a concept that they had not previously encountered as all previous scientific contexts involved only mass and volume. It was found that 80% of students who used a “packing” metaphor were able to correctly predict the equation for charge density as opposed to less than 25% of the sample (#N=126) who used other starting footholds. The main implication from this study is that when students ideas are based on appropriate foothold metaphors they will be more successful when extending their knowledge to new contexts. Thus, activities that activate appropriate metaphors effectively leads to an increased idea space.

“Fear” is regarded as one of the main drivers of decreasing the idea space by introducing monitoring functions into working memory as one consequence. A mild form of this notion is already apparent in the study on perceived audience discussed earlier but the effects are further explored here in a study on a group of “special access” postgraduate astrophysics students who transferred into their present university from various undergraduate institutions. The main purpose of the broad (and longitudinal) study was to try and identify issues that impacted negatively on their performance. In one related research exercise the students were given the word “astrophysics” at the centre of an otherwise blank piece of paper and asked to write any words, phrases, images, or diagrams that came to mind on seeing the word. Students were then asked to elaborate about what they had written. Amongst the findings were that students struggled at each level of study with a variety of tensions and conflicts that evolved in different ways as they progressed through their years of graduate study. Results from interviews carried out as part of the broader study show that while some of these tensions involved aspects beyond the immediate academic environment the source of much internal conflict involved academic contradictions that were perceived between their previous and present institutions, and more significantly contradictions within the new academic system. This made it difficult to “read” the system leading to continuous monitoring without arriving at a stable framing of the situation. Thus, students struggle through a process of managing and adjusting to internal conflicts that goes far beyond learning physics content knowledge in order to succeed, even in graduate school. These conflicts give rise to monitoring functions and need to be explicitly addressed in order to optimize engagement at the levels that are required for success.

Keywords: cognition, learning physics

PS.08.05.c

Strand 7: University Physics

Parallel Session 08.05

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D501 (4th Floor)

Gender differences in conceptual understanding of Newtonian mechanics: a comparison of UK and US students

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In this paper we present an analysis of the gender differences observed in conceptual understanding of Newtonian mechanics by over 650 first year undergraduate physics students at the University of Manchester, UK. This group contains about 20% female students. Data have been collected over the past four years using the Force Concept Inventory (FCI)(1). Students were tested upon entry to university and again after five weeks of instruction. We find a significant gender gap in the mean FCI scores, with the males outperforming the females by 10-20% both pre- and post-instruction for all four years. Other measures of attainment do not show the same gender difference.

A gender gap in conceptual understanding has also been reported at universities in the U.S. We have therefore compared our data with similar data obtained by Docktor and Heller(2) at Minnesota University. The latter data were obtained over a ten year period on over 5,600 (29% females) science and engineering students studying an introductory calculus based physics course in their first semester. Even though the overall test scores are somewhat lower than for the Manchester students, there are some interesting similarities in the responses to individual questions. Male students outperform females on almost all of the thirty FCI questions at both universities, and there is great similarity in the questions where we see large gender differences. This is surprising, since these students have been educated in different ways, indications of which can be seen in the differences in the pattern of correct answers on the FCI.

We have analysed the incorrect answers given by the students using Hestenes' taxonomy of misconceptions(3). The most common incorrect answers given to the two questions with largest gender difference indicate that female students are more likely to have conceptual difficulties with changing reference frames and to retain a 'common sense belief' that the last force to act on a body continues to determine its motion even though it is no longer acting. We are currently investigating gender-related differences in the reasoning approach to the questions. We conclude that this could have significant implications for the way in which Newtonian mechanics should be taught.

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Keywords: Gender differences, conceptual understanding, Newtonian mechanics

PS.08.05.d

Strand 7: University Physics

Parallel Session 08.05

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D501 (4th Floor)

Changing students' alternative conceptions in physics: an example of active learning of geometrical optics at university level

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Active learning is individual and group participation in effective activities such as: in-class observing, writing, experimenting, discussion, solving problems, talking about learned topics (DeBard & Guidera, 2000; Niemi, 2002). Some instructors believe that active learning environment is impossible, or, at least, difficult to achieve in large lecture sessions. Nevertheless, there is an experimental evidence, the most impressive in SCALE-UP learning environment (Beichner, et al., 2000), that such beliefs are false.

In this study we present a possible design of an active learning environment with strong positive effects on the students', based on the following elements: (i) helping student to learn from interactive lecture experiment; (ii) guiding student to use justified explanation and prediction after observing and exploring the observed experiment; (iii) development of conceptual question sequence designed for use in interactive lecture with a student response system by in-class worksheet writing and in-class discussion; (iv) assessment of student conceptual change and gains by exam question response in a week after the active learning session.

Our two research questions were:

- Can university students be more actively involved in physics learning when they attend the physics lectures within a large group in an amphitheater?
- Can active learning of geometrical optics help students improve their understanding of geometrical optics phenomena?

Data were collected from 95 freshmen who were with different secondary school background in optics. Students are divided into three groups: (a) the group of students who have learned geometrical optics only at primary school level (5%); (b) the group of students who have learned optics through undeveloped concepts both at primary and secondary school level (93%), and (c) the group of students who have learned optics as the (b) students' group, but who have had an additional, and elective course in physics/optics (2%). Student data concerning previous experiences with optics and mathematics were obtained by entrance questionnaire and entrance test. We found that all students were achieved their prior-knowledge in optics at quite similar level. Assessment of students' understanding of geometrical optics knowledge for reflection, refraction, and image formation was collected through their responses in-class worksheet writings and in-classroom discussions, as well as by the final exam questions.

The research questions open the problem of large class effective instruction which is not solved in traditional instruction which does not provide an effective model of teaching/learning physics. Students, involved in research, confirmed that they need personal and collaborative activities for engaging them actively in the physics learning processes. Our results, gained after only one active learning session, show that around 60 % of students have changed their alternative conceptions of vision and of image formation for the situations in which light refracts and reflects by passing through different media. Students who have adequately participated in the active learning sequence confirmed their better knowledge of the optics phenomena which they had never understood before. This paper presents also the role demonstrations and experiments should play in student learning in large-class learning environment. We consider that a traditional method of teaching/learning physics should be changed, even in case of a large group of university students who also like to be actively included in their learning instead of being obliged to a dominant passive role during teacher's talk-based lectures.

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Keywords: active learning, large enrollment university physics, geometrical optics

PS.08.06.a

Strand 8: Initial Physics Teacher Education

Parallel Session 08.06
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D502 (4th Floor)

Helping Primary Teacher Students to overcome their Lack of Motivation Teaching Science

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Science lessons are not very popular in school. At the time when science lessons are starting the interests and motivation of most learners are decreasing (Rheinberg, F. & Wendland, M. (2002). Thus we have a lot of students who are not interested in science and only a few who are interested in it in our classrooms. Usually (last semester: out of 60 students only 4 liked science in school) the students who want to become a primary class teacher are interested in working with little children and not focused on science (teaching). Exactly these primary teachers, however, are the first teachers interacting with the young children and teaching the 'first steps in science'. How we can overcome this lack of motivation?
Some researchers attribute this lack of understanding to the gap between the observed reality and the reality modeled in physics lessons. We cannot observe the exact mathematized laws of physics, which are taught in science lessons, in reality. But without discussing the fact that we are always modeling the world in physics lessons the learner might believe that physics is magic – he/she is not able to understand it.
We developed a framework, the 'Multiperspective Modelling' (Böhm, 2012) to explain the development of understanding physics. In this framework we take into account the prior knowledge of the students, the misconceptions and the different model perspectives that are interacting to understand a physics phenomenon. We want to uncover the hidden model perspectives for the learner (e.g. in early physics lessons we are speaking of swimming, floating and declining, but we do not talk about the fact that swimming is only possible at the boundary of both the liquids (media)).
In a special course (N=45) for primary teacher students we used this framework for preparing small science experiments for children. Every student had to prepare his/her experiment according to this framework, to collect practical experience by explaining this experiment to young children and to reflect this process theoretically.
To evaluate the students' motivation we used the EWF-LM questionnaire (Narciss, 2006) before and after the course. Due to the positive oral feedback in the course we suppose a better motivation in teaching science after the course. We are now in the process of evaluating the data and want to present the results at the conference.

Keywords: model perspectives, primary teacher students, multiperspective modelling

PS.08.06.b

Strand 8: Initial Physics Teacher Education

Parallel Session 08.06

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D502 (4th Floor)

Guided-Inquiry in Teaching Physics

Nouredine Zettili

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In this presentation, we want to discuss and contrast several pedagogical paradigms that are most effective in physics education. We focus on the use of guided inquiry in teaching physics and deal, in particular, with applications of this method in lectures, recitations, and labs. To illustrate how guided inquiry works in real life, we invoke few edifying examples from classical mechanics and electromagnetism. We argue that when properly wielded, guided inquiry becomes a powerful tool educators can use to infuse students with skills which will enable them become experienced learners, inquirers, and researchers. The aim here is to empower the students not only with how to construct and acquire knowledge on their own but also how to master a number of essential skills, most notably critical thinking and problem solving.

Keywords: Guided-Inquiry, hands-on approach, various pedagogical methods, teaching paradigms

Teaching future Physics teachers how to teach Physics in schools: perceptions on consequences of In-school Stage and orientations for Probation Year

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According to Bologna Orientations, implemented in Portugal for future secondary school teachers since 2008, Physics (and Chemistry) teachers have to complete a Master degree on Teaching Physics and Chemistry in Secondary Schools. During the last year of this Master degree, students have one in-school Pedagogical Stage (48 ECTS), during which they are both university students and staging school teachers. Although undergoing slight reforms, this Pedagogical Stage, lasting one whole academic year, supervised both by one school experienced teacher and one or two university professors, has already been compulsory for every future secondary school teachers' education in Portugal since 1973.
However, although not yet fully implemented, existing government directives imply now that, after graduation, a school teacher's first professional year will be a probation one. During probation, the young teacher is accompanied by a mentor, from the same scientific area, selected by the Pedagogic School Council, according to a pre-established professional profile. At the end of the year, the mentor evaluates the performance of the young teacher, following criteria established by law; if the performance is not satisfactory, the teacher cannot enter the teaching career.
Up to now there are no defined rules yet for how this probation year will be coached. Hence, it appears to be fundamental to start thinking about these two years as a complementary whole for future in-school teachers' basic education.
For a better understanding of the possible content and organization of this complementary two years' education period, we decided to collect information on the perceptions of recent staging school teachers on their Stage activities.
There are already some research works on school teacher's education in Portugal [1][2][3], but no one specially devoted to future Physics teachers. Based on Veenman, 1984, [4], Capel, 1998, [5] and Younger et al, 2004, [6] we have created a questionnaire, mainly with open questions, in order to collect information on secondary school coaching, on different activities attributed to staging teachers, on Stage organization and on School-University cooperation.
This questionnaire, which underwent a pilot phase, was answered by 59 Physics and Chemistry staging teachers, students from three different Universities, 7 young teachers (there is a severe shortage of in-school teaching jobs for new teachers) and 22 supervisors (4 school ones and 18 from the University).
Results point to some discrepancies among different groups perceptions. We can already notice the difficulty felt by staging and young teachers on school culture, on non-teaching support as contacts with parents, on meeting participation, on assessment, and on cooperative work among teachers. Also, young teachers refer the meager support of experienced colleagues and other school structures.
Our conclusions lead us to point towards a pedagogical initial Physics teacher education closer to reality. Universities and schools should work together to build a supporting scaffold recognized by both administrations, enrolling university professors and school teachers, able to coach less experienced teachers, to foster scientific and pedagogical physics teaching higher quality and to promote educational research in practice.
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Keywords: Probation year, teacher´s education

PS.08.06.d

Strand 8: Initial Physics Teacher Education

Parallel Session 08.06

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D502 (4th Floor)

Primary school teachers: Becoming aware of the relevance of their own scientific knowledge

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When we teach physics to prospective primary school teachers during their university training, we have to introduce the contents of the discipline in a manner that is relevant for the future profession of the teachers (Shulman, 1986). We have developed an approach to physics that is mindful of the cognitive development of children. The approach is based on some simple concepts that are funda-mental in physics and at the same time elementary for the learner. The concepts in question have a strong affinity to the primary schemas and images in the child's mind that result from early experi-ence (Fuchs, 2007, 2011). They rely on figurative structures of the human mind that are used to conceptualize not only natural, but also psychological and social phenomena. These figurative structures are pervasive in common as well as paradigmatic languages (Lakoff and Johnson, 1999; Johnson, 1987; Talmy, 2000).

The concepts we are speaking of make use of three schemas that form the basis of what Fuchs calls the Force Dynamic Gestalt (Fuchs, 2007). The schemas are quantity (size), quality (intensity and its differences), and force or power. In physics, they correspond to the concepts of extensive quantity, intensive quantity, and energy, respectively. If we add to this structure the concepts deriving from the mutual relationships between quantity, quality, and power, it is possible to build an innovative physics course well suited to primary school teachers that effortlessly includes the disciplinary aspects of physics. We expect teachers to be able to transform the approach quite easily for their own didactic practice.

The main question we are interested in is this: to what extent does this approach allow primary school teachers to become aware of the relevance of their scientific knowledge in their profession as educators?

At the Faculty of Education of the University of Modena and Reggio Emilia, a physics course has been taught to prospective primary school teachers (second year of the degree in Primary Educa-tion) using the approach afforded by the aspects of the Force Dynamic Gestalt (quantity, quality, force/power). These aspects span the topics of physics and form the basis of our metaphorical un-derstanding of forces of nature. The topics covered are: fluids (quantity: volume, quality: pressure), motion (quantity: momentum, quality: velocity), thermal phenomena (quantity: entropy, quality: temperature), electricity (quantity: charge, quality: electrical potential), chemical substances (quan-tity: substance amount, quality: chemical potential), and energy (balance between quantity and change in quality among coupled processes in a cause-effect chain). For each topic we analyze ex-tensive and intensive quantities and their mutual relations leading to the concepts of capacitance, resistance, current, and energy. The goal is to supply students with simple concepts powerful enough to scientifically interpret everyday situations that might also be encountered in school.

The second half of the course covers methodological issues where we design didactical activities for ages 5-11 which respect the cognitive and linguistic skills of children. We do this by making use of stories and narratives, experiments and general activities. The goal is to make the students expe-rience first-hand that natural language is suitable to teach "good science" and that it forms the basis of formal scientific languages.

To estimate the effectiveness of our approach, we evaluated three aspects of student understanding: (changes of) inclination towards physics, knowledge of the discipline, and ability to design didacti-cal activities for children of various ages.

The first point was assessed through a questionnaire about how students see nature and science after the course, their feeling toward physics, their awareness of understanding nature, their vision of their future work as teachers, and their personal evaluation of the course. The second point was tested through their answers to questions about physical processes that are part of our everyday experience.

To evaluate the third aspect, students had to deal with situations as they might actually arise in a classroom. For example, we gave them a story about a force of nature and asked them to design a didactical path for a class, including all the specifications (activities, scheduling, materials, group-ing, setting etc.), and explain every choice they made. Moreover, they were required to react to im-agined real and likely situations such as an unsuitable explanation heard during a class visit to a factory or a museum, or questions coming from one of their pupils, etc.

The detailed description of the course and the analysis of the investigation are the objects of this contribution. The main result of our study can be summarized as follows. If prospective student teachers learn that physics is not the representation of a truth "out there" but a representation of human imagination reflected in natural language, they become inclined to believe in their own pow-er to use good natural language to be good narrators of things happening in nature. Our results indi-cate that we can indeed empower student teachers to deal confidently with interesting and important issues of natural science in their classrooms where they actually make use of scientific content knowledge in ways appropriate to their pupils' state of cognitive and affective development.

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Keywords: Initial primary school teachers training, Force Dynamic Gestalt, stories, natural language

PS.08.07.W

Strand 2: Teaching Physics Concepts

Parallel Session 08.07 Workshop
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D504 (4th Floor)

School bag physics laboratory

Vijaykumar C Verenkar
The Progress High School, Sanquelim Goa India

Scientific laws, principles and concepts can be better understood and experienced by performing simple exp. and activities incorporating different teaching learning method with strategies with heuristic approach. Cognition of scientific laws is the best with child centered and activity based teaching and learning. Student can't fully appreciate their surrounding until they understand the rules of nature.Physics is about the rules of nature so beautifully elegant that it can be neatly described with simple experiments. Physics school bag lab involves no cost materials within our household. The physics experiments shown are with 'Zero' cost material and are designed and being demonstrated keeping in view two objectives.
* Students should learn & experience basic scientific laws, principles & concepts with the help of household material without using expensive laboratory apparatus.
* To train the students to be performer like me.
About 40 to 50 physics experiments are performed with the help of plastic pet bottle, candle, match box,thermocole, thread, straw,tubes,coin,ruler,paper strips, balloon, glass bottles, nail, newspaper,card paper,paperboard,post card, refill,scissors, table tennis ball, handkerchief, glass and saucer, detergent, hanger, compass box,etc.These materials are carried in a simple school bag and any child can perform numerous exciting experiments.
With the above materials following laws,principles, concepts, causes and effects can be demonstrated-Effect of atmospheric pressure, Turbulence of air, Compressed air, Phenomenon of resonance, pitch of the sound,centrifugal forces, Pascal's law, Bernoulli's principles,Surface tension, Mobius strip, corrugation,Reflection of light, Persistence of vision, Refraction of light, Dispersion of light, Simple Microscope, Newton's disc, Ben-ham's disc, conduction of heat and ignition temperature etc.

Keywords: Atmospheric pressure,Turbulence of air,Compressed air,Resonance,pitch of sound, centrifugal force,Newtons Laws of motion,Impulsive force,Pascal law.Bernoullis principle,Surface tension,Mobius strip,Corrugation,Reflection of light,

PS.08.08.W

Strand 15: Physics Teaching and Learning in Informal Settings

Parallel Session 08.08 Workshop
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: Smart Class

Experiencing data analysis from the world's largest science experiment

Konrad Jende
TU Dresden representing International Particle Physics Outreach Group

The world's largest science experiment, the Large Hadron Collider (LHC), has fascinated millions of people worldwide since its start-up in 2008. As Particle Physics is mainly fundamental research, operating at the edge to the unknown, it is one of the most intriguing fields of modern physics especially for students. It unites topics of natural science, engineering and philosophy. Due to intense reporting on current research results at CERN by the news media, student's interest on this field of physics is significant high. That is why adequate educational programs are needed.

The International Particle Physics Outreach Group (IPPOG) has been developed and organized an educational activity where students can experience the excitement of cutting-edge particle physics. "International Masterclasses" provide an opportunity for high school students to be "scientists for a day".

Three major experiments, namely ALICE, ATLAS and CMS provide International Masterclasses with real data and real analysis tools. They are the heart of different inquiry-based learning exercises and incorporated into a logic schedule starting with introductory lectures on particle physics. They are followed by hands-on exercises and result not only in local discussion sessions but also notably in a videoconference among all institutes which held Masterclasses on a particular day. All exercises are well-documented currently in 12 languages and the tools can be installed easily and freely on any modern PC or Mac.

On top of that International Masterclasses do not only attract students. At six days in 2012 teachers have been introduced to the same exercises and tools. They also work in pairs, discuss the graphical display of collisions in order to understand what is being presented and fill spreadsheets with their observations and measurements. Each pair analyses a different set of data, such that combinations of results can be performed.

In order to give a feeling how those hands-on exercises are performed we show all their features during a workshop. Starting with a guided tour that explains basic functions of the tools that are used in the exercise, we continue in deriving how particles and specific events can be distinguished and identified by independent work with text documents and small exercises. The independent analysis of a data set with the help of event displays is shared among the participants and is followed by discussions on its observations and results. After all that we discuss general questions on International Masterclasses.

We furthermore provide with and give access to all materials that are used by handing over DVD's to participants. The material consists of the explaining websites in multiple languages, event displays, spreadsheets and programs displaying histograms.

Keywords: particle physics, education, outreach, LHC, ATLAS, CMS, ALICE, workshop, scientific data, data analysis

PS.08.09.W

Strand 4: Laboratory Activities in Physics Education

Parallel Session 08.09 Workshop
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D406 (3rd Floor)

Simple and Beautiful Experiments V by LADY CATS and Science teachers groups

Haruka Onishi[1], Masako Tanemura[2], Kyoko Ishii[3], Fumiko Okiharu[4], Masaaki Taniguchi[5], Junichiro Yasuda[5], Mika Yokoe[6], Hiroshi Kawakatsu[5]
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LADY CATS (LADY Creators of Activities for Teaching Science) is an organization of science teachers consisting of female staff ranging from primary to university.
Many schoolgirls and some primary teachers, especially female teachers, have little interest in physics. Female physics teachers and researchers are in the minority in Japan. We formed the "LADY CATS" group at the ICPE in 2005 in order to challenge and find a solution to these problems. We try to encourage girls to study physics and female teachers to teach science. At international conferences and workshops, along with our male colleagues, we show simple and beautiful experiments which demonstrate the principles of physics which also fascinate and inspire students at the same time.
Our experiment concepts are, “Simple”, “Beautiful” and “Essential”.
“Simple” experiments are low cost (Primary schools do not have enough budget) and are easy to perform (Anyone can do them). They make use of common, everyday tools and materials that can be found worldwide.
“Beautiful” experiments are attractive to children. They are not only visually appealing to them, but the final outcome of the experiments usually contradicts their predictions. With these experiments it is also our aim to try to catch female students’eyes and see them from a female point of view. By this we mean showing them the “beauty” of physics.
“Essential” experiments help students to learn established scientific ideas and theories. They are able to obtain a great deal of new information and knowledge about natural science.
Furthermore, we believe that these ideas may help resolve gender related problems and would be a great help to non-specialist teachers in primary schools.
Cheap, effective materials for teaching physics will be presented on our hands-on workshop.
For example:
The Geiger-Müller counter (GM counter) is a detector that measures ionizing radiation. We can make this apparatus from everyday items, for example, a film case, plastic cups, aluminum foil and so on. With this experiment, students and non-specialist teachers can learn about radiation and how we can detect its presence.
Through the Fukushima nuclear plant accident, we believe there is a greater need to teach students more about radiation. By doing so, we hope students will be able to make future decisions regarding nuclear energy etc. from a levelheaded and educated point of view.
Faraday’s Motor (Unipolar Generator) was developed and demonstrated by Michael Faraday in 1821 at the Royal Institution in London. You can easily make a Unipolar Generator using a wire, a battery and ferrite magnets. This experiment helps primary and high school students to study about electromagnetism with interest.
Other examples easily made are, a triangular kaleidoscope, a “buzz top generator”, a sound motor and so on.
If you would like to know more about our activities, please attend our presentation.
Let’s enjoy physics together!!

Keywords: simple and low-cost experiments, attractive to children, teacher training, scientific experiments, gender problem

PS.08.10.a

Strand 9: Teacher Professional Development

Parallel Session 08.10
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D506 (4th Floor)

Teacher Training Program with Interactive Lecture and Experiments using Physics by Inquiry

Kyoko Ishii, Yoshihide Yamada
University of Fukui

This paper reports our challenge of developing the teacher training course program to promote student's understanding and interest to learn physics.
In Japan, many primary teachers teach science but feel difficulty in teaching science especially physics. They usually haven't learned science deeply at high school and have few experiences to feel interest to learn it. So they feel they don't have much understanding, knowledge and skills to teach science/physics. From our research, we found the non-majored students have lost motivation to learn physics because they couldn't understand but memorize to pass the examination. PISA results also tell us Japanese students are good at memorization and reproducing scientific knowledge but not at motivation. It might cause that many teachers in primary school cannot cultivate student's curiosity and interest in science/physics. But once they know the meaning to learn and understand it, they can learn more interestingly.
Our interest is how to provide in-depth understanding and good experience to learn in the university. We try to promote their understanding of the contents and to raise motivation to teach science. One of the weakest topics is electricity even they have chance three times in the primary school. So our first challenge is focus to the electricity.
We translated "Physics by Inquiry" in Japanese and practiced at primary school and secondary school. (Ishii et.al, 2000) We found that it is almost the same structure as Japanese Course of Study. So we made the program for teacher training course for Japanese teachers by arranging Physics by Inquiry and Course of Study. The program is with experiments, demonstration, interactive lecture, peer instruction and simulation movie with PhET to promote interest and understanding.
In this report, we introduce a 180 minute program which we developed and practiced. We also introduce the student's learning process, reaction and reflection. The contents of program is mostly based on the theoretical order, like single-bulb circuit, electric current, series and parallels networks, resistance, etc.
We think teachers teach like the way they have learned. Teachers who learn science as inquiry can teach science as inquiry, we think. So we try to improve our program to provide opportunities scientific inquiry for the students to learn not only contents of knowledge but also pedagogical content knowledge through their practice.

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Keywords: teacher education, electric current, curriculum, faculty development, physics by inquiry

How Science Teachers' Utilization of Computers Change through a Targeted Professional Development Program

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Introduction
The world is changing in 21st century even faster than we predicted and this changing world people called "the generation of computer literate people". For the growth of computer literacy people, computer technology should take place in education. Teaching in the 21st century requires teachers to take advantage of the unique features of computer technologies and to implement it in instruction (National Research Council, 1996) because students have a lot of experience with new technology in their daily lives therefore teachers should make lessons relevant to students' everyday lives. This study sought to explore development of in-service science teachers' views towards utilizing computer animations and simulations as an integral part of their classroom teaching.
Aim of the Study
The aim of this study is to explore effects of targeted professional development program to in service science teachers' computer usage.
Research questions
In the present study, the question remains: How does in-service teachers' computer usage change at the end of targeted professional development program? Within this scope, the sub-purposes of the study can be listed as follows:
1. to determine teachers' views about computer usage regarding their teaching in science classrooms,
2. to analyze teachers' scores of effectiveness of TPDP survey
3. to examine effectiveness of targeted professional development on teachers' usage of computer in teaching.
Methodology
The study took place within the context of a targeted professional development program (TPDP). The TPDP consisted of modules to promote utilization of inquiry-based interactive computer animations and simulations. After learning basic computer usage skills and ways of utilizing computer animations and simulations in teaching science, teachers created lessons on different science subjects to practice and demonstrate their learning. They also taught lessons to their peers and had them reflect on their teaching. A non-random purposeful sample was used to gather data from in-service science teachers that participated TPDP for 5 days. The sample of the research consists of 43 in-service teachers, who work as a primary science teacher in public schools. Both quantitative and qualitative research methods were used to investigate the effectiveness of TPDP. The data collection instruments included effectiveness of TPDP survey and semi-conducted interviews. The effectiveness of TPDP survey consists of 12 close-ended, 4 open-ended questions. Twelve questions are about general characteristics' of teachers and 4 open ended questions about effectiveness of TPDP. Semi-structured interviews were conducted with 4 voluntary in-service science teachers who replied the survey.
Results
Most of the teachers included in this study lack of skills necessary for the efficient use of computer technology as an instructional tool in the classroom therefore they had concerns about using computer widely in teaching. The results from this study indicated that after attending professional development training course, majority of the teachers developed positive views on using computer technology in their class and its effect on to the learning. They reported using computer is beneficial for teaching-learning process. Targeted professional development program enable them to successfully using computers in the classrooms. It seems clear that teachers' skills and knowledge about computer usage might affect how they use computer resources. Successfully integrating technology into science education heavily relies on the development of well-built, coherent professional development programs that are designed with a clear understanding of how teachers need to use technology in their class in the most effective way. As a result, TPDP had positive effect on teachers' usage of computer in teaching. The findings emerging from the data analysis showed that the TPDP was effective in changing in-service teachers' teaching habits and including more ICT elements in teaching. Thus, we conclude that the TPDP we developed was a successful effort.

Keywords: In-Service Science Teachers, Technology Supported Teaching, Professional Development Program, Mixed Methods Research

PS.08.10.c

Strand 9: Teacher Professional Development

Parallel Session 08.10
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D506 (4th Floor)

In-service teacher training for using of IT in inquiry based activities

Marian Kires, Zuzana Jeskova
Institute of Physics, Faculty of Science, UPJS Kosice, Slovakia

The science education in Slovakia currently faces new challenges connected with the new curriculum reform running from 2009. The reform emphasizes the role of scientific inquiry in education that is in good correspondence with massive European movement oriented on implementation of Inquiry based science education. The contribution presents the key ideas of in-service teacher inquiry-based education within Slovak national project Modernization of education at primary and secondary schools which is aimed at the implementation of new ways of education enhanced by IT. The main goals of the four-year national project (2009-2013) are creating instructional materials on the use of IT and appropriate teaching methods and train up to 7000 in-service teachers for their reasonable application in the class. Among them there are 543 physics teachers who participate at the 9 days course aimed at the effective use of IT in physics education. The paper presents examples of teacher training activities for key competences and scientific literacy development. The authors formulate conclusions from evaluation questionnaire used after the in-service teacher training graduation.

Keywords: in-service teacher training, physics education, inquiry, IT in education

PS.08.10.d

Strand 17: Various Topics in Physics Education

Parallel Session 08.10

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D506 (4th Floor)

Connecting use of technology to academic achievement

Homeyra R Sadaghiani

California State Polytechnic University, Pomona

Whether technology should be used in education is no longer the issue, instead, the current emphasis is ensuring that technology is used effectively to engage students in the process of learning and in promoting their academic achievements. In fact, educational technology requires the assistance of educators who integrate technology into the curriculum, align it with student learning goals, and use it with proven effective strategies and curriculum materials.

This talk will focus on utilizing technology to enhance student learning and performance in introductory and advanced undergraduate university physics courses. Examples include incorporation of personal response system (clickers), iPads, and open source computer simulations in classroom activities.

Clickers offer students a pedagogically powerful blend of intimacy and anonymity that can move them from passive to active learning with the click of a button. A clicker is an electronic voting device that resembles a basic remote control, which interacts with a software that tabulates the responses and can then display the distribution of answers on a bar graph. In practice, a professor presents a multiple choice or true/false question. Students then respond by pushing buttons for answers (a), (b), (c), and so on.

The resulting data provide faculty instant feedback on how well students are learning the new concepts and what difficulties still need to be addressed. In addition, clickers provide an incentive for students' consistent engagements and feedback on their own performance in class.

Clickers are a technology that has been infused into my classroom over the course of the past eight years: initially used only as a data collection tool, the clickers are now integrated into the fabric of my introductory and advanced physics classes. They are utilized in a variety of different ways, including: conceptual questions, demo predictions, Socratic questioning, scaffolding of problem solving steps, and for connections between different topics among others.

Far from being simply the latest new gadget, iPads offer students a wide variety of dynamic applications and powerful visualization tools. In addition, using a variety of powerful new applications, class lecture notes, including audio, are readily available for students' later review.

I will discuss the strategies to engage students more effectively by integrating theses technological tools with research-based course material in a variety of different settings. Examples of best practices that have shown to improve learning outcome will be discussed.

Keywords: Physics Education Research, technology, clickers, iPads, computer simulations

PS.08.11.a

Strand 7: University Physics

Parallel Session 08.11

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D505 (4th Floor)

The Learning approach on Percolation under Quantum Hall Effect conditions at the post graduation Level

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This research investigated the role of learning approach on the Percolation under Quantum Hall Effect in improving the concepts of students and teachers at university level. In this report some results in current percolation are reported. The percolation under Quantum Hall Effect conditions in inhomogeneous medium is thoroughly studied. Both the upper and lower bound values are obtained, which are found different from the values for metal conductivity. We connect it with the unusual character of current percolation under the regime of Quantum Hall Effect. As a basic model the two dimensional system, consisting of the phases with different conductivities, is considered. The phases are placed in a random way and in the double periodic structure also. For two-phase case it is shown that effective conductivity essentially depends on the micro geometry of the medium and the generalization of the Dykhne formula for the parallelogram unit cell is obtained. The percolation under quantum Hall effect conditions is studied by the general approach, using the symmetry of the system. The features of current percolation in QHE regime are established, the effective characteristics and the local current distributions are founded.

The aims of this research are:

1. To provide an understanding of Percolation under Quantum Hall Effect for the students at graduation level.
2. To give the basic requirements and knowledge for easily understanding of a scientific research paper at this level.
3. To introduce and involve university students and teachers in new research.
4. To improve their classroom practices and specially to enable teachers to foster critical thinking in students.

In this oral presentation, we will describe the position paper which is based on facts that provide a solid foundation for understanding the new research for the research's student as well as for the teacher.

The Percolation model represents the perhaps simplest example of a system exhibiting complex behavior. I hope these investigations will be very much helpful for the graduate level students as it has many useful applications.

Keywords: learning approach, Quantum Hall Effect conditions, improving the concepts of students, Dykhne formula.

PS.08.11.b

Strand 7: University Physics

Parallel Session 08.11

Date & Time: 04.07.2012 / 13:00 - 14:30

Room: D505 (4th Floor)

The de Broglie wavelength and frequency of the scattered electrons in Compton effect

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In the undergraduate textbooks on modern physics [1-3], the concept of particle nature of wave is introduced prior to that of wave nature of particle. The latter is demonstrated by the Davisson-Germer experiment. The former is illustrated using Compton effect where a photon collides with a stationary electron that is treated as a particle using laboratory frame of reference. Rarely these textbooks discuss the possibilities of explaining the Compton effect by assuming the wave nature of the photon and the electron, and also whether the scattered electrons have wave nature. Therefore these discussions can lead to a better understanding of wave-particle duality, a central concept of quantum mechanics. The de Broglie frequency of the scattered electron in Compton effect has been equated to the difference between the frequency of the incident and scattered photon under non-relativistic conditions [4]. A wave interpretation of the Compton effect has been suggested [5]. This work is motivated by the solution provided by a student for a problem posed in the first year undergraduate examination on modern physics course for engineering students for finding the de Broglie wavelength of the scattered electron in the Compton effect. The wave characteristics of the scattered electrons are obtained from the familiar Compton scattering mechanics where photon and electron are treated as particles [1-3]. We obtain the expressions for the de Broglie wavelength and frequency of the scattered electrons in terms of wavelength and frequency of the incident and scattered photons respectively. For an incident photon of wavelength=7.114 nm that was used in the original experiment of Compton, the de Broglie wavelength is in the range of 36-93 pm while the de Broglie frequency is comparable to the frequency of the internal clock of the electron as suggested by de Broglie [6]. The wave nature of the scattered electrons for a given scattering angle of the photon can be confirmed in principle by electron diffraction experiment.

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Keywords: Modern physics, Compton effect, de Broglie wavelength, de Broglie frequency, wave nature of electron

PS.08.11.c

Strand 7: University Physics

Parallel Session 08.11
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D505 (4th Floor)

Understanding wavefunction properties: a case study on 3rd year Italian physics students

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Issues emerging from research on university student learning of quantum mechanics (QM) have shown the existence of following problem areas concerning the role of formalism within the theory:
1. Properties of valid Wavefunctions (WF): while analyzing a particle in a potential well, students struggle to identify which continuity constraints and boundary conditions a complex valued function of a real variable must satisfy, in order to describe the quantum state of a physical system [1, 2]. Singh claims that students' "responses displayed that they do not have a good grasp of Fourier analysis" [1].
2. Physical information and formal entities: often students lack a clear understanding of how physical information is encoded in QM formalism, e.g. failing to discriminate between probability amplitude and probability. According to research literature, this issue arises from a poor understanding of probability [4, 8] or inability to distinguish between closely related entities [1, 9].
3. Complex nature of WF: as elicited in studies about graphical representation of WF, students ascribe different physical meanings to the real and imaginary parts of WF [5-6, 9-10]. The alleged asymmetry has been associated with textbooks tendency to represent graphically only the real part, "but referring to it as the WF" [10].
4. WF as description of the state at a single instant: while analyzing tunnel effect [7] or step potentials in general [1], some students assign time dependent characteristics to stationary WF and to its components. This issue seems related to classical thinking [7], and to the use of the simple, but ideal/formal plane wave model [10].
Above mentioned studies aimed at identifying the origins of relevant issues focusing primarily on formal aspects, rather than the conceptual role of formalism, i.e. the physical meaning of superposition principle and of quantum state, based on the former, of boundary conditions and continuity constraint WF must satisfy, of its complex nature [3, 11, 12].
For this reason we stated the following research questions:
1) Which meaning do students assign to properties of valid WF and to its stochastic nature?
2) Which role do they assign to complex nature of WF?
3) In plane wave representation of tunneling, do they associate the components of a WF with the same instant or different ones?
A preliminary case study was conducted on three 3rd year physics students from University of Perugia, Italy. Students were tested after they attended the first half of a standard course in QM, and before taking the course exam. All participants had been high performing students through their undergraduate career (average grade 27-29/30).
For the present research we designed and administered some essay questions in written form, concerning all four specified topics.
At a later date we conducted individual interviews on each student.
The three students displayed different profiles on properties of valid WF ("satisfying Schrödinger equation", "normalizability", "hermiticity") and its probabilistic meaning ("impossibility of precise measurements in QM", or associating the "WF square modulus to energy measurements"). Two students used WF as a descriptor for time evolution of physical systems. The third student recognized that WF and its components are associated to the same instant, but couldn't elaborate further on the links between plane wave model and quantum scattering.
For all students, complex numbers don't play a role in QM. They are used because "sine and cosine can be expressed in terms of complex exponentials", or "only out convenience".
From the analysis of the three case studies, beside documented difficulties, following elements emerge: students think that mathematics doesn't play a conceptual role in QM, but is only a set of formal rules used to determine probability or measurement outcomes; the physical meaning of QM is condensed in slogan sentences, lacking a coherent conceptual framework and connections to formalism; only superposition states are considered in measurements, disregarding unitary and zero probability cases; temporal reconstruction of processes dominates even when temporal coincidence between different components of WF is recognized.
Our findings show that: a) even good performing students need contexts as a base for building the conceptual foundation of QM formalism; b) overemphasizing computational aspects obscures the physical meaning of formal entities. The results obtained motivate future investigation on how student learn the conceptual role of QM formalism.

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Keywords: physics education research, student difficulties, quantum mechanics, wavefunction

PS.08.11.d

Strand 7: University Physics

Parallel Session 08.11
Date & Time: 04.07.2012 / 13:00 - 14:30
Room: D505 (4th Floor)

The pedagogical challenge of quantum field theory

Robert Lambourne
The Open University, Milton Keynes, UK

Quantum field theory arises from the fusion of special relativity and quantum physics. It is an important tool in many areas of physics and is at the heart of particle theory. Even string theory, which some see as a successor to quantum field theory, is still clearly related to it and has several obvious links. Many students are exposed to elements of quantum field theory in the late stages of their undergraduate university studies, though most do not experience their first full course in quantum field theory until they are graduate students. Whatever the context, most students agree that quantum field theory is a very hard subject, yet almost all the major textbooks assert that quantum field theory is really a very straightforward subject, some even claim that it is easy. Why is there such a difference between those being taught and their teachers? What is it that really makes quantum field theory hard for students, and why do so many of the experts appear to lose sight of the difficulty as they become more familiar with the subject? This talk will review some of the concepts that students must master as they study quantum field theory and try to identify the features that make their absorption a serious challenge for even the best graduate students.

Keywords: pedagogy, concept, quantum, relativity, field theory, university

JULY 5, 2012
THURSDAY

PS.09.01.a

Strand 2: Teaching Physics Concepts

Parallel Session 09.01
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D401 (3rd Floor)

Learning progression and core physics ideas in astronomy

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Learning progression-based research is an interesting field facing the problem to overcome the fragmentation of educational intervention about many topics through the school years. Literature about learning progression makes reference to the necessity to identify one or more big ideas in a domain, to define levels of increased sophistication of contents and practices, to obtain empirical data for validation (NRC-National research Council,Taking science to school K-8, 2007; NRC- A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, Washington, DC: The National Academies Press, 2011).
Some learning progressions in astronomy K-8 guided by big ideas strictly related to physics have been recently proposed. In particular Plummer (Challenges in defining and validating an astronomy learning progression, in Learning Progressions in Science - A. Alonzo & A.W.Gotwalds Eds., forthcoming) proposes just one big idea, the motion (and properties) of celestial objects, in a progression from earth-based perspective of astronomical phenomena to the heliocentric model of the solar system. We only partially agree with this progression. We designed and tested a progression in three phases, not necessarily separated and consequential: a topocentric phase (based on the observations above the horizon of the observer); a geocentric one (looking at what happens to the entire earth surface using the Parallel Globe and sharing qualitative observations and data between locations at different latitude and longitude); the heliocentric one (Rossi, Giordano, Lanciano, The parallel globe and the Globo Local project, Girep 2011).
In addition we found that it is impossible to consider just motion as core or big idea; necessarily basic ideas about light propagation in space and vision from different perspectives have to be added. (First steps of a learning progression about light and vision are presented by one of the author in the website http://didascienze.formazione.unimib.it/lucevisione where she shows the importance to work in parallel on light and vision; Gagliardi, Giordano, Recchi, Enseñanza de las Ciencias, 2006).
In this presentation we will propose with more details our physics in astronomy learning progression and some empirical data as a possible validation. Some students' results from kindergarten (3 years old children) to 8th grade (14 years old students) will be presented and discussed. In particular we will try to clarify the idea of increasing appropriation (suggested by Guidoni as cited in Levrini O., in press) that we suggest to use instead of increasing sophistication. In our opinion it allows to better describe and interpret the process of knowledge construction by very young children, in a way already very sophisticated.

Keywords: learning progression, physics in astronomy, appropriation

PS.09.01.b
Strand 2: Teaching Physics Concepts
Parallel Session 09.01
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D401 (3rd Floor)

Praxeological Organization of School Knowledge: A comparison of the Clapeyron equation approach in both physics and chemistry textbooks

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INTRODUCTION
This work presents a synthesis of the Didactic Transposition (DT) and the Anthropological Theory of the Didactics (ATD) of Chevallard as well as the relationship between them. These theories are then used as an analysis tool to understand the appearance of the content on the Clapeyron equation in both Physics and Chemistry textbooks adopted by high schools in Brazil. This analysis tried to answer the questions: for what reason the Clapeyron equation appears both in textbooks of physics and chemistry? Why does this doubling end up extending also to the classroom? Is there a didactic or pedagogical relevance behind this duplicity? We believed that this duplicity stemmed from a lack of communication between those who set the curriculum of high school physics and chemistry, however, the results did not supported this initial hypothesis.
We used the ATD because of its potential for unveiling the knowledge and providing insight into their specificities.
Chevallard (1991), on DT describes the epistemological journey of learning from its origin to the classroom. According to this theory, throughout the teaching of any knowledge, there are three different levels, namely academic knowledge, knowledge to be taught and knowledge taught. The first is related to the original knowledge, which is built by the community of scientists and only becomes public after its publication in scientific journals. There is a need for a first transformation of this original knowledge, called external didactic transposition, which leads to the second level of transposition, the knowledge to be taught. This transposition basically consists in transcribing the contents of the academic knowledge to textbooks so as to make it teachable for students.
The second transformation of knowledge is made by the teacher within the classroom, who uses the knowledge of these books and adapts the content to order and sequence their lessons. This step is personal and susceptible to some variables, such as the environment of the classroom, class level of interest and others. This stage of transformation of knowledge to be taught in knowledge taught is named internal didactic transposition.
The Didactic Transposition is a promising framework which first started in the area of mathematics and proved useful in other sciences, like physics, chemistry and biology. However, this analytical theory comprises mainly the sciences which have an academic knowledge, as is the case of physics and mathematics. In order to cover the humanities, Chevallard extends his theory to the Anthropological Theory of the Didactics, describing human activities and their institutions in a praxeological and anthropological perspective (Chevallard, 1999).
In this theory, human activities are fitted in two components: a theoretical and a practical one. The first component, the logos, refers to the knowing (technology and theory) and the second, the praxis, refers to the doing (task and technique). These two blocks forms what Chevallard calls Praxeological Organization.
The Task refers to anything a human being needs to do on a regular basis, for example, solving quadratic equations (student's task), teaching the Pythagorean Theorem (teacher's task), cutting wood (carpenter's task), etc.
The Technique is the method by which one accomplishes a task. Quadratic equations, for example, may be solved by various techniques, such as the completion of squares, Bhaskara`s method, etc.
The Technology is the rational discourse that justifies and explains the use of the technique used to accomplish a task, ensuring that this technique will fulfill its purpose. It clarifies the scope of the technique, besides producing new techniques.
The Theory explains and justifies the claims of technology. It is the rational discourse about it and has, for technology, the same role technology has for technique, i.e., the theory is the technology of technology.

METHODOLOGY
The researches that inspired our work and used the ADT for the analysis of textbooks are presented in the articles of Kurnaz, Arslan (2010) and Poisson (2011). These authors performed a careful reading of textbooks in order to detect praxeological organizations related to a specific content. Our study was designed to assess the tasks and techniques present in praxeological organizations related to the topic, thus enabling the analysis and comparison of approaches used for the content in the two books chosen. For this purpose, we analyzed the chapters on Clapeyron equation in these two books (i. Topics in Physics - NEWTON, volume-02, publisher Saraiva, 2007, ii. Chemistry - RUTH, single volume, editor Attica, 2010), looking over the excerpts which could represent elements of praxeological organization of this subject. Finally, we categorized the tasks in two types: common to both and specific.

CONCLUSION

Physics textbook suggests problems that relate tasks regarding Clapeyron equation with tasks regarding other fields of physics (specific tasks). The same proved to be true for chemistry textbook. In this sense, our initial assumption that the praxeological analysis would be identical for both books proved to be incomplete, because there are very different types of tasks in both cases. However, there seems to be a common core to both books. The initial tasks are of the same type (common to both), and intend to get the reader familiar with the equation, with its constraints and units. This common core validates, partially, our hypothesis that the doubling was due to lack of communication between institutions, since there is no need for an exhaustive approach of this equation in both courses. Perhaps, for that teacher who is to address this equation for the second time, it is enough just doing a review on what was already studied and, thereafter, initiate specific applications of their course.

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Keywords: didactic transposition, the anthropological theory of the didactic, textbooks

PS.09.01.c

Strand 2: Teaching Physics Concepts

Parallel Session 09.01

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D401 (3rd Floor)

The importance of learning styles in teaching thermodynamics

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To help improve high school students' learning and their perception of physics, a group of university teachers work side by side with high school teachers in professional learning communities. Opposite of what appears in literature, we believe that high school teachers should be actively involved in developing teaching approaches, materials and sequences, to be consistent with the actual conditions of the high school classroom.

In these learning communities, different topics of the curriculum had been addressed, trying to define appropriate ways of teaching physics at high school level. Each work is not independent; all are part of an inclusive project, approached from different angles and always taking into account the relation of physics with daily life, environment and culture. The research question is how the applied method, in each case, promotes better learning. All of the high school teachers have many years experience working at this level so it is easy to compare the results of the groups both before and after having introduced the new approach.

With this research question in mind, different teaching techniques had been used. In all cases, the students (15 to18 years) are taken into account as follows: what they know and think; the environment where they live and their interests. Context is important; students' interests are different depending on what they want to do in life and on their socioeconomic status and parents' education; although all of us live in Mexico City, a Western globalized city.

The general project is illustrated in this work, with the specific way in which the study of thermal phenomena was approached introducing different learning styles, beside the general methodology of the project. The study was done at Colegio de Bachilleres, a public high school in Mexico City, in 8 groups with a total of 380 students. Since students with different learning styles represent the world differently, teaching was done so that everyone could learn. Special attention was paid to kinesthetic students, as traditional teaching favors the audio learning of style students. Although the investigation was done in thermodynamics, the same methodology has been used by the same teacher in other areas and groups.
From this work it follows that all students feel involved in the class, do not skip and have more interest in physics. There was a change in attitude which favors learning. To appreciate their learning, we have their graphical representations, mind maps and finally their scores which are compared with the scores of other groups of the same teacher in previous years.

Keywords: learning styles, high school physics

PS.09.01.d

Strand 2: Teaching Physics Concepts

Parallel Session 09.01

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D401 (3rd Floor)

The practical essence of the Supporting Physics Teaching Initiative (SPT)

Ian Lawrence

Institute of Physics, UK

The SPT initiative of the Institute of Physics (IoP) has produced materials that have been out in the hands of supporters of teachers seeking to develop teachers pedagogic content knowledge since 2006.

During that time the materials have moved from CD-ROM format, distributed to all trainee science teachers in the UK, and available internationally (copies are known to have reached 135 E and 45 S, to a downloadable rich PDF format, now embedded in a (Web 2.x) community of teachers of physics (5000) at TalkPhysics.org. So several thousand teachers have used the materials in one way or another.

This talk, by one of the original project leaders, will focus on the essence of the design and aspirations of the materials by focussing on three core areas of physics in which teachers and their supporters have made good use of the materials, so reflecting on successes and lessons, rather than a recap of the history of the project. (Although it's gestation was originally a collaboration: drawing on the extensive research base that has developed over the past 30 years; the best efforts of the original team, of university-based teacher trainers working with experienced teachers); a top-notch multimedia company; educational and physics academic referees; and then exploiting the Institute's commitment and connections to polish the materials.)

This usage has been extensive in the UK, focussed on facilitating personal study for trainee and early years teachers, and providing the backdrop for the highly successful Stimulating Physics Network (managed from the IoP and involving 70 field workers). I hope the talk will serve as a springboard for further international engagement with the materials and as a means of sharing the structure of an approach that clearly has traction.

Rather than being an attempt to pioneer an innovation in a particular topic, through a teaching experiment (rather often a focus of GIREP talks), the materials seek to bring a coherence to physics through a careful consideration of many of the rituals embedded in current practice. I hope that this work, which focuses on the core competences of teachers of physics, can serve as a catalyst for others to build on this development.

Neither the evolving publication model, nor the particular design of the graphical communication will be covered in this talk, although both are essential to the richness and continuing success of the whole (these are the subject of posters, as this a more appropriate medium).

Rather I'll focus on three core areas where teachers of physics (whether specialists or not) and their supporters have benefitted from working with the materials.

- the teaching of energy
- the teaching of forces
- the teaching of electric circuits

This should be of interest to anyone who works to develop or research the development of, pedagogic content knowledge in teachers, as all of these areas are core competences and areas where difficulties lie in wait for learners (including teachers).

After the talk, outlines of workshops will be obvious to experienced supporters of teachers (including any teachers who support colleagues), and researchers will have another iteration of teaching approaches to consider, critique and reflect on. Although not an ideal introduction, teachers who are not familiar with the materials will probably get a sufficient feel for the heft of the materials to be able to get started. The materials themselves are freely downloadable from TalkPhysics.org. Web based versions are evolving, but that's part of another story.

Keywords: teacher, PCK, development, CPD, in service training, pre service training, supporter

PS.09.02.a

Strand 3: Learning Physics Concepts

Parallel Session 09.02

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D402 (3rd Floor)

The misconception - concept transition

Clemens Wagner

Solid State Physics and Education, ETHZ, Zuerich, Switzerland

Concept learning in physics is a difficult task. Very often students try to stick to their misconceptions until the course has finished. Despite that they have learned in some cases to apply the true concept to problems they never exchanged the misconception by the concept. Rather both, concept and misconception are present in the students mind during the learning phase. However, as soon as the learning phase is over unfortunately the concept knowledge decreases and the misconception prevails.

We have developed a model of the transition between misconception unlearning and concept learning. Our model shows two stable fixed points: in the misconception fixed point the student doesn't know anything about the concept and applies to all problems his misconception. In contrast, in the concept fixed point the student applies in the far majority of problems the right concept. In order to get reasonable parameters we have fitted our model to the data of concept learning published by A. Heckler.

Although misconception unlearning is always helpful it is not very effective if it is not done at the right time. If concept learning occurs on top of a stable misconception, a few months after the learning event all concept learning is gone and the misconception reigns again. To prevent such a learning outcome, our model shows that addressing misconceptions right at the beginning of the learning phase is most efficient. The proper learning of a concept in our model supports the unlearning of the misconception, which explains our results. We have extended our model to include two misconceptions, however, our major statement still holds.

Keywords: concept learning, conceptual change, misconception, modeling learning

PS.09.02.b

Strand 3: Learning Physics Concepts

Parallel Session 09.02

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D402 (3rd Floor)

Naive Conceptions in Terms of Affordance Theory

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In the community of physics education research it is widely known that the mind of a student who starts to learn physics is not a kind of tabula rasa but full of "naive conceptions". Usually, the process of cognition and the formation of naive conceptions are interpreted within cognitive science. For example, the well-known naive conception that "object tends to stop" may be understood as a schema formed by association of perceptual knowledge about various kinds of motion observed in daily life. Cognitive science tells that perceptual knowledge is constructed in the brain as a result of processing of data coming from sensory organs.

The idea of direct perception by J. J. Gibson gives an alternative interpretation about the construction of perceptual knowledge and naive conceptions. According to Gibson, direct perception is for exploring "affordances" of things in the environment. Roughly, the affordances of things are what they furnish, for good or ill, that is, what they afford the observer [1]. For example, a ball (or a small stone) affords throwing, and a wall affords collision (or climbing). Exploring affordances is very substantial for lives of all animals, including that of human beings. In the theory of affordance the perceptual and conceptual knowledge are not different in kind but are both forms of cognition in different levels [2]. For understanding the origin of naive conceptions, it seems very important to pay attention to Gibson's following notion: "When we talk about the perception of abstract "space" or the perception of "motion" in the sense of Isaac Newton we are confusing the two levels and making the problem of perception insoluble."[2]

In this presentation we point out that some of naive conceptions can be well interpreted in terms of direct perception. Typical examples are found in distractors in FCI. For example, the distractor of Q.4 (c) in FCI, "neither exerts a force on the other, the car gets smashed simply because it gets in the way of the truck", may be associated with the affordance of "a vertical rigid surface, an obstacle, affording collisions and barring locomotion" [3]. A preliminary result of an analysis of FCI data from the point of view of affordance will be given.

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Keywords: naive conceptions, affordances, perception, cognition

PS.09.02.c

Strand 3: Learning Physics Concepts

Parallel Session 09.02

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D402 (3rd Floor)

Using self-generated analogies in teaching of thermodynamics

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Analogies have used extensively in physics teaching in order to connect a new field of study, a target domain, to what the students already know, a source domain. However, it has also been recognised that analogical teaching is not unproblematic, but rather a 'double-edged sword', since it may lead to unintended inferences. The students are confronted with two challenges: First, they need to have a thorough knowledge of the source domain. Next, they have to see in what respect the compared domains are supposed to be similar. One way out of this conundrum may be to ask students to come with their own, self-generated analogies. In our research project, we have set out to investigate the effect of asking students to generate their own analogies as a way to express and develop conceptual understanding in thermodynamics. In a first study, we asked eight (N = 8) preservice physics teachers, working in groups of four, to come up with analogies for two thermal processes. The were confronted with the 'stretched target' of accounting for constant temperature in free expansion and constant entropy in adiabatic, reversible expansion of an ideal gas. As a result, the participants came up with a large number of analogies, some of which were recalled from previous teaching and others that were novel. The participants were found to take more ownership for their novel analogies, as several of them were scrutinised and developed to a great structural depth. In a second study, the children in one class of first-graders (N = 25, age 7-8 years) were first found to be able to grasp the analogy between a car, a bicycle and a walking girl, in that all provide means of locomotion, in spite of them being superficially dissimilar, supporting post-Piagetian research on young children's ability to perform analogical reasoning, provided the domains are known and the task at hand is understood. After two predict, observe, explain (POE) exercises on (1) mixing of marbles of two colours on a see-saw and (2) heat transfer from a hot-plate to a frying pan, the children were asked to come up with and make drawings of 'things that work in the same way', in other words analogies. While most of the children focused on superficial similarities, some of them were able to come up with analogies focusing on the relational structure. One example is a clothing iron heating a board with plastic beads, corresponding to the hot-plate heating the frying pan, in spite of the potential distracter that you hold the heat source in the former case, but the heat receiver in the latter. Another example is that the marbles ending up 'mixed' was compared to the disorder created if you drop a bag of groceries, reminding of the common (but criticised) 'messy-room' introduction of entropy in introductory physics textbooks. In conclusion, self-generated analogies were found to be a promising avenue for ascertaining participants' conceptions of thermal phenomena, but also to have a potential role in concept development.

Keywords: self-generated analogies, conceptions, thermodynamics

High School Students' reasoning in thermal conductivity. A comparative study between Catalonia and Greece

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Results of international evaluations shown us, that students' abilities in different aspects like for example performance in reading; mathematics and science are different in several countries but not many comparative studies can be found in the literature. The present study is an attempt to examine and compare students' arguments in thermal conductivity in Catalonia and Greece, two typical Mediterranean civilizations with similar cultural characteristics.
Related to research on science students' conceptions, there have been attempts to identify general strategies of reasoning that were not related to a specific content of the questionnaire or the interview (Andersson, 1986; Guidoni, 1985, 1990; Maurines, 1991; Rozier and Viennot, 1991; Viennot, 1996;...). Our research is related to those attempts.
The framework that we choose for this study comes from the area of philosophy and rhetoric. From previous researches we have done, we know that the Perelman's argumentation theory is very has been useful to analyze students' arguments. We are able with this analytical framework to go further of the identification of students' ideas that of course has been a research topic in the last decades. We wanted not only to compare students' ideas between the two countries but also the different parts of the structure of their arguments in this particular topic of physics. Specifically, we use the "techniques of argumentation" (or argumentative schemes) as they appear in his book "The new Rhetoric" for our analysis.
Methodology
It's a qualitative study that includes various activities from different physics topics. In this conference we present the analysis of one task. The task was given to twenty-five 13-to-14-year old students of public high school students of each country. Both groups had to analyse a cartoon in which three children discuss about the proposal of putting a coat on a snowman. According to the first kid, it should be put on, as the coat will keep it cold; according to the second, it will make it melt; according to the third, the coat will not make any difference. The students were request to provide their opinion choosing between the three children's' conclusions, supporting their claims with arguments. The activity had two parts. In the first part, students had to solve the task individually and then they have to discuss their ideas in small groups of 3 or 4 students for approximately 20 minutes. The group discussion was recorded and later transcribed.
Analysis- Results-Discussion
The process of analysis was performed in both countries in two phases.
The first phase was aimed at identifying the argumentative technique used by the students (Perelman, 1969) in their written first part of the activity. The transcription of the second part of the activity was analysed to clarify aspects of their implicit premises that were not clear in their written part and to confirm the "techniques of argumentation" that during the discussion were revealed. The researchers performed this part of the analysis independently and the results then were compared. The results of the analysis were coincided in more than 90% of the cases.
The second phase has the aim to identify the fundamental background knowledge often related to their implicit premises.
The preliminary results show us that in both countries the majority of students based their reasoning on arguments based on the structure of reality and more specifically to cause to effect and pragmatic arguments (more than the 80%); there has been also a small number of analogical arguments.
The preliminary results show us that there are no any significant differences between students' arguments in the two countries. They both share similar misconceptions that some of them are related to the similar climate conditions of the two countries, as for example that the snow always has to melt. We think that this kind of an analysis can show us more clear the problematic aspect of students' arguments and ideas. Furthermore comparative studies could help us understand if there is a relationship between students' arguments in different countries and possible different factors that can influence students' ideas.
Perhaps, interested results of this type of comparison could be the appearance of similar argumentation schemes that are more related to human way of thinking, meanwhile they share different premises, that are more influenced by cultural and geo-climatically factors.

Keywords: secondary school, argumentation, prior knowledge

Improving student learning in physics laboratories through the professional development of laboratory demonstrators

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An essential component of all physics degrees is the laboratory program. Laboratories enable students develop many of the practical and theoretical skills required to be successful scientists, as well as providing the basis for a deeper understanding of the scientific method. Students learn to link theory to practice, problem-solve, control parameters, take measurements, understand and calculate experimental uncertainties, graph and interpret data, work in teams, and communicate by writing cohesive reports and papers.

Universities invest considerable funds in building laboratories, furnishing them, buying sets of appropriate equipment for the experiments, writing lab manuals etc. However, traditionally very little attention is paid to the instructors of the laboratories sessions. These instructors (called "laboratory demonstrators" in Australia) are often PhD and Honours students who are the least experienced members of the teaching staff. The laboratory demonstrators normally begin their teaching careers in first year laboratories where both they and their students are new to the laboratory experience. In these situations, the laboratory demonstrator can have a profound influence (either positive or negative) on the student learning experience.

To address this problem, we at Curtin University have developed a one-day workshop for new (and more experienced) laboratory demonstrators. In this presentation, we will outline what we do, why we do it, and what has been to impact on our participants and on our first year students. We will provide details of our workshop and an electronic copy of our workbook to encourage colleagues from around the world to take up and adapt our workshop.

During the workshop, the participants discuss topics such as: What is my role in labs? What is expected of me by the University, the School, my coordinator and the students? What are the aims and learning outcomes of laboratory classes? What factors impede or facilitate these aims? What does current science education research tell us about teaching and learning? How can I create a successful learning environment? How do I encourage understanding using the Socratic method? How do I best provide my students with verbal and written feedback? How do I deal with difficult situations which may occur in the laboratory class?

Keywords: Professional development, laboratory demonstrators, student learning in laboratories

PS.09.03.b

Strand 9: Teacher Professional Development

Parallel Session 09.03

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D403 (3rd Floor)

Determining Physics Teachers' Misconceptions about Basic Astronomy Concepts with a Three-tier Test

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Why astronomy is important for physics teaching?

Astronomy is not only the oldest of all sciences, but it can also be called the mother of all sciences. Trumper (2006) states that 1) the study of astronomy can lead to a better understanding of the world. 2)other research fields in science can be incorporated in, and enriched by, the study of astronomy. 3)new discoveries in astronomy create interest and can be exploited to increase students' motivation to learn science. 4) the study of astronomy can display the growth of knowledge as a process of developing, discarding, and replacing explanatory models. Besides, European Association for Astronomy Education-EAAE (1994) reported that astronomy and astrophysics have come to play a central role in the natural sciences, with many direct links to other sciences (e.g., many aspects of physics, mathematics, chemistry, and the geosciences).

Astronomy teaching includes the fundamentals of the scientific method, comprising the associated doubt and lack of answers and the interplay between experiment and theory, thereby forcing students to adopt a critical attitude toward the many pseudosciences(Trumper, 2006). However, studies show that students and science/physics teachers don't have a sufficient scientific literacy about basic astronomy concepts.

In light of these facts, the main purpose of this study is to determine the misconceptions of physics teachers about basic astronomy concepts. For this purpose, the Astronomy Concept and Achievement Test (ACAT), including 28 multiple choice questions, developed by Trumper (2006), was revised as three-tier and used as data collection instrument. The study was conducted with 216 physics teachers from different schools and cities in Turkey. During two years, teachers attending a one-week inservice training programs about new high school physics curriculum in the Turkey were selected to participate in this study.

The first tier in ACAT, concept or the problem is asked as multiple choice questions. In the second tier the reason or justification of the answer given to the first tier is asked. In order to discriminate misconception from lack of knowledge, in the third tier, they are asked to what extent they are sure about their answers in the first and second tiers as choice namely "I am sure- I am not sure".

To assess physics teachers' conceptual understanding as achievement test, it was given a true score to the teachers who chose the correct alternative in the first-tier and the corresponding correct reason in the second tier and they had been sure about their answers. Likewise, to assess teachers' misconceptions, it was given a score to the participants who chose the misconception alternative in the first tier and the corresponding reason in the second tier and they had been still sure about their answers.

As a result of the research; in terms of achievement, physics teachers' test scores are very low. While the average score of teachers is 11.4 at the first-tier, in the other tiers their scores are extremely low. On the other hand, teachers hold a series of misconceptions about moon's phases and rotation-same side visible, moon's phase in solar eclipse, reason for seasons.

Keywords: astronomy education, misconceptions, physics teachers, three-tier test.

PS.09.03.c
Strand 9: Teacher Professional Development
Parallel Session 09.03
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D403 (3rd Floor)

Recent professional development programs for practicing physics teachers in Armenia: Are they in line with international trends?

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“Quality” and “relevance” are the most important key words of the 10-year general education reform project, financed by the World Bank in Armenia. It started in 2004 and the first 5-year phase of the project ended in 2009. The second 5-year part will be finished in 2014. In-service teacher professional development is one of main objectives of the project. During the first phase, a physics teacher professional development program (PDP) was designed and carried out nation-wide. In 2011, a new physics teacher PDP was prepared and the second wave of nation-wide teacher training began in the autumn of the same year. This PDP should be carried out during the second phase of the project. The two PDPs were prepared under the assistance of the World Bank`s educational consultants. The main objective of the study was to determine the influence of contemporary Western theories of science education, including theories of situated learning, and models of science teacher professional development on the two above mentioned PDPs for practicing physics teachers in Armenia. The study addressed the following questions: 1) What modern approaches to science curriculum development, teaching and learning methodology, and assessment of student’s achievements are included in these PDPs? 2) What competencies should be developed in teachers? 3) What methodology of instruction of teachers is proposed? Who are instructors? How effectiveness of the PDSs are planned to be evaluated? What similarities and differences between the PDSs are in light of the above defined questions? The main finding from the study shows that despite the presence in these two PDPs of almost all main contemporary concepts of science education and teacher professional development (standards, inquiry-based science education, project- and problem- based teaching/ learning, case- studies, learning environment, performance assessment, formative and summative assessment, competencies, teacher as facilitator, educator and researcher, pedagogical content knowledge, continuous professional development, school-based professional development and others) they are not clarified and used as it should be. Such superficial, not in-depth presentation of modern approaches to science education and science teacher professional development can hardly prepare physics teachers of Armenia for implementing the objectives of the reform. This is so mainly because the transfer of educational knowledge from the developed Western world into the Armenian context was predominantly made through training activities, emphasizing technical skills rather than foundations of contemporary educational theories. The paper discusses some other possible reasons for the situation and recommendations for its improvement.

Keywords: Education reform, professionsl development program, physics teaching and learning, knowledge transfer, context.

PS.09.03.d

Strand 9: Teacher Professional Development

Parallel Session 09.03

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D403 (3rd Floor)

Mentoring as a form of professional support for South African physics teachers

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This study reports on mentoring as a form of professional support for South African physics teachers in coping with curriculum reforms. Teachers in South Africa feel overwhelmed by the challenges presented by the reforms in the physics curriculum due to their lack of professional development. Teachers have bemoaned the lack of substantive support from the South African education department. The in-service training provided consisted mostly of one-shot workshops in which the new policies and terminology were explained, with very little offered in terms of professional development in the content knowledge, pedagogical content knowledge or concrete examples of how to facilitate scientific investigations. Such professional development efforts have been criticised by many researchers as being brief, fragmented, incoherent encounters that are de-contextualised and isolated from real classroom situations (e.g., Feiman-Nemser, 2001; Villegas-Reimers, 2003) and compromising science education reform (Anderson & Helms, 2001).

This study reports on mentoring as a form of professional support for physics teachers in dealing with curriculum reforms associated with the implementation of a Physical Sciences curriculum. Mentoring has increased in popularity as a way by which a teacher experiencing some weakness in his/her practice can be supported by a skilled and experienced colleague (Bradbury, 2010). A review of literature undertaken by Lai (2009) shows that mentoring has been conceptualized with respect to its relational, developmental and contextual dimensions. Mentoring is a multi-faceted and complex concept, and we took a position that it is best understood from the three perspectives outlined.

Using a case study method, we investigated two cases of mentoring. The schools were purposefully selected as they depicted cases where Physical Sciences teachers were involved in mentoring relationships. Data were collected through interviews with the teachers, listening to discussions between the teachers and classroom observations over a period of three months. The first case explored a traditional mentoring relationship between a novice teacher and a more experienced and competent teacher whom we referred to as a “keystone species” of the profession. The second case described a more collaborative form of mentoring between two experienced teachers who exploited each others’ strengths in overcoming some of the deficiencies in their practice.

From a relational perspective the dynamic nature of the mentoring relationship was revealed in the case of the mentor-mentee relationship as the mentoring roles changed as the relationship evolved. Initially the relationship was one-sided as the mentee had a strong dependency on the mentor in seeking advice on how to overcome the challenges he experienced in his teaching. With time the novice teacher with his increasing confidence and competence started to engage more collaboratively with his mentor. The relationship was becoming more egalitarian and the initial delineation between the roles of mentor and mentee was becoming increasingly blurred. The findings of the case study suggest that mentoring although complex does provide a viable means through which professional development efforts can be consolidated.

Keywords: Professional developmeny, mentoring, curriculum reforms

PS.09.04.a
Strand 6: Secondary School Physics
Parallel Session 09.04
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D404 (3rd Floor)

An integrated approach to the teaching and learning of physics and mathematics utilising technology

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Increasing the uptake and the performance of second level students mathematics and science, especially higher level mathematics and the physical sciences, has been identified as a national and international priority. In light of this, an evidence-based research project was undertaken at the NCE-MSTL, Ireland. The aim of this study was to develop, implement and evaluate a collaborative integrated teaching and learning approach to physics and mathematics. The pedagogical focus of the study was an Inquiry Based Learning (IBL) approach, utilising technology, with the aim of improving students' conceptual understanding of physics and mathematics. It was intended that the students would experience physics and mathematics in a new way, using technology and examples that had a real-life application, and accordingly it facilitated a deeper understanding of key physics and mathematical concepts. This was undertaken through the integration of a handheld graphic calculator into the teaching and learning of science and mathematics in first year classes (age 12-13) in three second level schools in Ireland. A Teaching and Learning Network (TLN) was set up between the three participating schools. One mathematics teacher and one science teacher worked in collaboration, with each other and the NCE-MSTL team, in each of the participating schools. Through this TLN, the science and mathematics teachers in each school developed lesson tasks incorporating mathematics into the science class with an emphasis on IBL. These lesson tasks were presented to the other teachers involved from the two other schools and ideas were shared, assembled and collated. Action research was the central methodology of this study. A key outcome of this project was the development of specific lesson tasks that helped facilitate the integration of both subjects. The study was evaluated through teacher interviews and lesson observations where an independent observer attended the science class. The qualitative data reports the teachers' experience of the project. The key findings emerging from this study in relation to the model of integration and TLN are outlined in the paper. The paper will focus on the outcomes of integration, lessons learnt in this two year project, along with essential elements that need to be consider when integrating both mathematics and science utilising technology at second level education.

Keywords: Second level education, physics, mathematics, Integration, technology, Inquiry Based Learning (IBL)

PS.09.04.b
Strand 6: Secondary School Physics
Parallel Session 09.04
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D404 (3rd Floor)

Interactive Multimedia related to real life, A Model to teach Physics in high school

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The most basic of physics, is all around us and is related to everyday life situation and human life is subject to the universal laws of physics. Frequently, pre instructional images from everyday life interfere with the concepts to be learned in Physics instruction and there are only some limited success results. Learning environment "everyday live physics" usually means using physics to explain phenomena we see in everyday life.This research investigates 'use of knowledge' by multimedia where knowledge is taught in specific contexts taken from life outside and inside school.
Research examines how successful students are in conventional exams where real world contexts are trivialized and laboratory/school contexts dominate, and compare this with an assessment where context varies but is not trivialized and is real world. In particular, the research investigates how effectively students are able to transfer their learning of physics concepts across the differing real-life contexts found in interactive multimedia, and finally onto a non-contextual situation.
The plan needs a Physics computer software context-based student learning material which provides a self-study program in physics for secondary students to use with the support of their teachers. The learning material is set within a real-life context by using interactive Physics software in virtual space. One of this online software is accessible in the website: http://www.physics.org/interact/physics-life/web/physics_life/
There is an interactive multimedia which is designed for students to get along with and do researches about Physics concepts in life.
By using particular learning strategies, the project aims to motivate students to learn by increasing their interest in Physics in everyday life. The plan starts with some questions about observations, then finding the concepts related to Physics in environment.At the end,looking for concepts explanation through web pages and self–learning.
The steps for teaching strategy are:
1- Pre test exam about Physics in text book related to interactive multimedia,
2- Using software and interactive multimedia to concentrate on environment and Physics concepts. To make students think about Physics concepts.Real-life context was chosen before the associated physics content and the content is not ordered in the traditional way found in most syllabi and textbooks. Planning some activities and using them in each session or their home as homework.
3- Motivating students to find the relation between Physics concepts and real life.
4- Discussing about concepts in each group and show results to class.
5- Post test exam related to textbook concepts.

This research investigates how effectively students are able to transfer their learning of physics concepts across the differing real-life contexts found in the interactive multimedia. Learning is context dependent but context-based learning is a complex phenomena and it could be supported by this method. This has led to the same Physics concepts being taught in more than one unit, but in different real-life contexts.
By using pre-test and post-test, results have shown the effects of this plan on teaching Physics. The research was done for 50 students in 2 groups, one group as an experimental group and the pre and post test were the same for both of them. Students who were target of this research were very active in learning concepts of energy and its applications,in addition their ability to analyze the real life phenomena was improved.
This has the advantage of providing more practice for students so reinforcing learning and enabling students to make links across different domains. Students generally found the context approach through interactive multimedia more accessible, interesting and memorable their previous experiences of physics learning.

Keywords: Interactive,Multimedia,Real life,Teach Physics,High school

AccessNano: a unique secondary school resource making nanotechnology accessible to young Australians

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AccessNano: a unique secondary school resource making nanotechnology accessible to young Australians.
Abstract
The SHINE program was launched in 2007. Since then the Australian Government has supported the expansion and development of this idea into AccessNano, a national nanotechnology school resource for ages 12-17. AccessNano is presented in the form of 13 diverse and flexible web-based modules, featuring PowerPoint presentations, experiments, activities, animations and links to interactive websites. The resource has been carefully curriculum matched across the states of Australia to allow ease of integration into existing teaching programs, and supported by a series of Teacher Professional Development seminars. The relevant and accessible nature of AccessNano will provide young Australians with an introduction to the amazing potential of and diverse issues relating to nanotechnology, as well as providing new pathways for teaching of science and technology in a relevant and exciting format.

1.0 Introduction
Like any new technology, nanotechnology must be introduced to and debated by society at large before it can be fully accepted. The Australian Office of Nanotechnology is Federal body coordinating the National Nanotechnology Strategy within Australia to encourage appropriate policy development around and public engagement with nanotechnology. During 2008 the AON funded the development of AccessNano, a web-based national secondary school nanotechnology resource designed to provide not only a new approach to teaching high school science, but also an accessible pathway to introduce a new generation of potential consumers, innovators and policy makers to the basic concepts and broader issues relating to nanotechnology. AccessNano, based on the innovative SHINE program previously developed in Australia, was launched in November 2008 by the Australian Federal Minister for Education The Honourable Julia Gillard MP. It was produced by Bridge8 Pty Ltd (www.bridge8.com.au) in close collaboration with science teachers Francesca Calati and Dr Amanda Clarke and with input from Australian nanotechnology academia and industry.

2.0 Pedagogy
Recent statistics from the Australian Council for Educational Research paint a grim picture for the future of science study in Australian secondary schools. Similar trends are seen across the globe. AccessNano offers a unique approach to teaching in that it (a) uses nanotechnology to frame the pedagogy of the traditionally-taught school sciences such as chemistry, biology and physics, and (b) touches on other subjects including art, philosophy and social studies to place science and technology within a broader context. At the centre of AccessNano is an emphasis on applications of nanotechnology in existing products and scientific endeavours, supported by unique demonstration and experimental components, so that students are able to perceive nanotechnology phenomena first-hand and see its potential applications in their daily lives. Furthermore, the resource uses prompts and activities to encourage students to understand and participate in the debate about technology development and regulation. Rather than convince teachers to change the focus of their science teaching in order to incorporate AccessNano, scientific content was carefully selected to match existing curriculum requirements across the states of Australia.

3.0 Modules: The backbone of AccessNano
AccessNano is presented in the form of 13 modules targeted at secondary school years 7-11 (ages 12-17). Each module consists of a PowerPoint presentation and experiments and activities with guided notes for teachers to provide support and background information. Extra web-based resources are included where appropriate. Modules can be used as is, or modified to suit a particular classroom environment. In Junior Science, the Space Elevator module is built around an assignment where students research the use of carbon nanotubes to build the space elevator. The Shape Memory Alloy module uses nitinol to explore the structure and properties of metals. In the Middle Science modules Scale & Measurement and Properties, students learn about scientific notation and the metric system, and compare material properties at the bulk and nanoscales. The modules Performance Materials: Carbon Nanotubes and Performance Materials: Textiles encourage a consideration of covalent and intermolecular bonds and polymers in the context of nanotechnology. Modules Health & Medicine: Drug Delivery and Health & Medicine: Nanogold offers a glimpse into how nanotechnology may revolutionise preventative medicine and diagnostics. Relevant for senior physics, chemistry and biology students. The Glass module provides insight into how nanotechnology can be used to modify an existing and well-known product, while Personal Care Products encourages students to consider issues around the

emergence of nano products in the market place. The Social Issues: Magazine and Social Issues: Utility Fog modules provide students and teachers with pathways to consider the impact of nanotechnology on society. The Senior physics and chemistry module Gold is designed to allow students to see how knowledge of basic chemistry and physics principles and practice can be applied in cutting edge new technologies.

4.0 Teacher Professional Development

In 2009 a series of AccessNano Teacher Professional Development seminars were launched across Australia to assist teachers in implementing this unique nanotechnology education resource. The program provided theory, practical advice, hands-on demonstrations and integrated approaches to support teachers using AccessNano. Delivered by Mrs Francesca Calati, SHINE developer and winner of the 2007 Prime Minister's Prize for Excellence in Teaching Science in Secondary Schools, the program also featured guest speakers from nanotechnology academia and industry to reflect the integrated approach applied in developing AccessNano. Feedback has been very positive, and supported the view that AccessNano is truly a unique resource with a strong role to play in reinvigorating teaching of science and technology in Australian secondary schools.

5.0 Conclusions

AccessNano is a unique, cutting-edge nanotechnology educational resource designed to introduce accessible and innovative science and technology into Australian secondary school classrooms. It is different from most other nanotechnology education initiatives available globally as it provides an integrated approach to teaching nanotechnology. The relevance of AccessNano to the local arena and its suitability for the classroom has been prioritised through close collaboration of the development team with industry, academia and science teachers across Australia. AccessNano will be developed further to reflect the ever-changing nature of nanotechnology and its impact on product innovation.

Keywords: Nanotechnology, emerging sciences, accessnano, physics, education, highschool science, professional development,general science, nitinol

Interactive Physics Laboratory and Collection of Demonstration Experiments

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Practical work takes traditionally an important part in physics education. Students are being impressed by their teacher's demonstrations, they do experiments (also laboratory ones), and once or twice a year they can take part in a school project. Students face experiments mainly in school thanks to their teachers.
To give Czech physics teachers further examples of experiments for their demonstrations and to augment students' chances for doing experiments two projects were established: "Interactive physics laboratory" and "Collection of demonstration experiments". One of main goals of both activities, which are held by the Department of Physics Education, Faculty of Mathematics and Physics, Charles University in Prague, is to increase students' interest in physics.
The main purpose of this paper is to inform about those activities for high school teachers and their students. We hope that they could inspire other activities somewhere else and lead to cooperation, exchange of experiences and good practice.
The Interactive Physics Laboratory (shortly IPL, Czech web pages are at the address http://kdf.mff.cuni.cz/ifl) is a laboratory where teachers are invited to come with their students to do mostly experiments with tools which are too expensive for regular high school or experiments which are in some way innovative and even teachers do not know them yet. IPL organizes also courses for teachers where they can go through the same experiments themselves and gain experience with them before coming with students.
The idea of IPL in Prague was inspired by Swedish House of Science [1], [2] and was presented at Girep 2009 in Leicester, UK for the first time. The contribution [3] concerned mainly our vision based on the survey made into teachers' opinions. On the base of all answers the laboratory started its operation.
The Collection of demonstration experiments is an internet database (for Czech version see http://kdf.mff.cuni.cz/pokusy/) which is dedicated mainly to physics teachers. The system is based on Collection of physics tasks (http://www.physicstaks.eu) already presented at Girep conference, which enables easily to structure the text and other materials concerning each experiment. The Collection of demonstration experiments was established within a project dedicated to improvement of a seminar which prepares future teachers for doing demonstration experiments. The vision of such website was mentioned in our contribution at Girep 2011 in Jyväskylä, Finland [4]. The collection is done, in use and nowadays covers the area of Electricity and magnetism, which includes nearly fifty manuals to experiments supplemented by figures, schemes and videos.
First part of this contribution presents our experiences with working laboratory and activities done by students during their visit. On an example of experiments and relevant materials for students concerning Electrostatics we will demonstrate what students actually do in our laboratory. The second part of the paper concerns the Collection of demonstration experiments. The whole concept of the collection will be presented as well as selected experiments. The interface of the collection is nowadays in Czech only but in case of international collaboration it could be easily translated into any other language.

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Keywords: Physics, demonstration experiments, laboratory experiments, secondary school, students, teachers, collection, Electricity and Magnetism

Promoting active learning in experimental physics courses of the Engineering career using the Moodle platform

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The purpose of the reported activity was to promote active learning and higher engagement of students of Basic Experimental Physics courses of the Engineering career.
In general, engineering students are not really motivated by Physics Laboratories, and it is difficult to achieve a real engagement of them in the proposed experimental activities, that in most of cases are presented as "cookbook Labs". Due to the massive character of our courses, students have only six attendance classes (3 hours, bi-weekly) per semester (on the second year of their university career). In each class they have to perform an experimental activity and deliver a written report a week after. This structure does not promote sufficient communication and interaction between students and with the teacher.
We decided to complement face to face classes with online activities and to work on a blended form mixing cookbook and less guided activities.
There are several studies about the use of inquiry versus more guided techniques, specifically in the field of laboratory courses (Kirschner 2006, Wenning 2006). We consider it is necessary to have some guided experiences that help student to learn basic principles of experimental work and data analysis. On the other hand, it is important to face them with more opened activities, where they can put in practice concepts and tools learned before. Our students learn how to realize a basic physics experiment using cookbook experiences in four of the six classes of the course. The last two classes are dedicated to a single activity giving them more time to make the experiment, analyze the results and discuss with other students, so developing other skills as critical thinking, speaking and presenting their ideas orally and writing.
We introduced activities before and after each session, using just in time teaching method elements (NOVAK 1999), using Moodle platform. Before the experimental class students had to study specific material and answer online questionnaires related to theoretical and experimental topics, and work on simulation activities. The last ones had the aim to prepare them to the experimental activity. During the whole course, moderated forums by teachers were available to discuss and exchange ideas and experimental results. All reports were uploaded on the platform and teachers corrections and comments were returned in real time. Concerning the last activity, which had a month duration, students had to prepare also an oral presentation. Once the presentation file was uploaded, their colleagues had to analyse and comment it. Finally, each subgroup had to present its results to the rest of the students as a short seminary.
The engagement, motivation and performance of students were clearly increased by the implementation of these activities. The preparatory online activities helped them to better face and solve problems during the experimental activity. The increased interchange allowed students to discuss the results and their implications more deeply.
The activities were positively evaluated by students by means of a final inquiry. They highly appreciated the oral presentations, which for most of them was the first oral activity in their university career.

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Keywords: Physic Labs, Moodle, universitary courses

PS.09.05.b

Strand 7: University Physics

Parallel Session 09.05

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D405 (3rd Floor)

Open Inquiry investigations on heat transfer performed by undergraduate engineering students

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Many researches have shown the pedagogical effectiveness of the Structured Inquiry as a high performance tool in science education of undergraduate engineering students [1-3].
In this work we report on the preliminary results of an extended investigation on the efficacy of the application of an Open Inquiry (OI) approach to the consolidation of the physics concepts regarding the topic of heat transfer. We have selected a sample of 25 undergraduate mechanical engineering students which passed the examination of the basic physics courses with good marks. Firstly we have investigated about resistant misconceptions in thermal physics by administrating a pre-activity concept inventory. Even the best marked students have shown several deficiencies for what concern, in particular, the practical knowledge of the physics of energy exchange by thermal radiation.
Our Open Inquiry activity has involved the students in a highly challenging learning environment, starting from the problem of projecting a thermodynamically efficient space base on Mars. Students have been asked to work in groups and to perform scientific investigations regarding the best materials to use in the construction and the best design strategies to practice in order to collect as much thermal energy as possible during the Martian day, having an average maximum diurnal temperature of about 20 °C, and avoid heat dispersions during the cold night (Tnight = -140 °C). Students have been stimulated to design and carry out their own laboratory activity by collecting, processing and analysing data, in order to discover new concepts and obtain more meaningful conceptual understanding of the physics underlying the process of thermal energy exchange by conduction, convection and radiation. All groups of students have been invited to share the results of their explorative works within each other during the conclusive discussion. Lastly, a final post-activity evaluation test has been administered.
Our Open Inquiry learning path has proved to be a great opportunity of enhancing the practical skills of our engineering students. We discuss in detail the advantages and limits of the OI-based teaching approach.

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Keywords: Inquiry-Based Science Education, heat transfer

PS.09.05.c

Strand 7: University Physics

Parallel Session 09.05
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D405 (3rd Floor)

Física 1++: An experience with Cooperative Learning in the first physics course at the Faculty of Engineering

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Physics 1 is the first physics course of Faculty of Engineering. It is a semiannual course that is taught both in the first and second semester of engineering. The rate of disapproval of this course and the dropout rate in the first year is very high. Basically, 70% of the students disapprove and must sign on once again. About 50% of the students entering the faculty says study alone, and over 70% responded negatively to the question "studying in groups of 3 or more".
Cooperative learning has become a popular subject in the last 30 years. According to Johnson, Johnson and Holubec (Johnson et al, 1994): "Cooperative learning is the instructional use of small groups through which students work together to maximize their own and each others learning." Specific studies to investigate the effects of cooperative learning in the area of physics show that the solutions to problems obtained by groups working under the cooperative learning method are better than solutions obtained by the best student in a traditional course (Heller et al, 1992).
Given the above, we performed a project to implement for the first time in the Faculty of Engineering, the cooperative learning method. This experience was carried out in the Physics 1 course. The regular course of Physics 1 consists in 6 hours per week of lectures by professors and expositions of exercises by teaching assistants.
We performed the cooperative learning method in the second semester of 2011 simultaneously with the regular course of Physics 1. We worked with a population of 64 students (divided into 2 groups of 32) who preferably had taken the course once. The two subgroups underwent the same evaluations as the regular course.
Within each group, students worked in subgroups of 4 members which were formed by the teachers. As a prerequisite to class attendance, students should read in some of the course books, the topics that were to be developed in the classroom. During the week, the 6 hours of attendance of the course were divided into 3 sessions of 2 hours. They worked in the following ways:
Conceptual exercises: working specific exercises in order to analyze the concepts previously studied and identify typical misconceptions.
Contextualized problems: problems without prior modeling where students are faced with a situation of "real life" that did not previously know and they must to model.
Worksheet exercises: practical exercises, similar to the regular course. The students should work in these exercises outside the classroom and sometimes in class.
Each group worked cooperatively, learning together and from their peers, while the teachers intervened subtly giving some guidance or explicitly when the group could not resolve an issue.
RESULTS and **CONCLUSIONS:** The performance of the students who worked cooperatively was much better than the students of the regular course: 23.70% of approval versus 5.20%. We should also stress that our students remained highly motivated and committed to the proposal throughout the semester, developed a greater predisposition to teamwork and improved their communication skills. There was a more analytical approach to problems. These preliminary results are highly positive, showing the effectiveness of the method which will continue to implement and improve.
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Keywords: University Physics, Cooperative Learning.

PS.09.05.d
Strand 7: University Physics
Parallel Session 09.05
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D405 (3rd Floor)

Linking different domains of physics through the mathematical tool of integrals

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The traditional teaching of physics in separate domains leads to rote learning and fragmented understanding that hinders deep understanding (Bagno et al., 2000). Students who complete introductory physics fail to see physics as a coherent knowledge structure (Redish et al., 1998). In addition, mathematics, for many students, becomes a barrier to physics understanding and problem-solving. This study investigates how particular features of physics problems in an introductory physics course support student learning in different curriculum domains. The key features of the problems used are the use of the integral in mathematics and calculation of the area under the graph. In a course specially designed for the preparation of physics teachers, we tried to relate problems of different domains through the mathematical tool of integrals. In other words, integrals have served as a tool to unify problem-solving in different domains of physics (Arons, 1997). This was done through problems from the series of the curriculum 'Understanding Physics' (Cummings et al., 2004) and then, through the development of similar problems by the instructors. The physics domains are those of kinematics, kinetic energy and work, thermodynamics and electromagnetic induction. The problems were used in the teaching and assessment process. The aims of the described one-year course were to foster conceptual understanding, develop problem-solving skills and attract students' attention to physics 'behind' mathematics. This piece of research is placed within the undergraduate program for physics students in our Physics Department and in particular, it is based on the need to design special courses for prospective physics teachers (McDermott, 1990). The course was implemented with two pilot groups of Greek university students (twenty students in each group) to explore how the problems facilitated student understanding and development of problem-solving skills. Pre-and post-tests before and after instruction were completed in paper and pencil by the participants. Students were also asked to 'think aloud' while working on problems. In analyzing students' answers (qualitatively and quantitatively), we attempted to assess whether there were significant differences between their performance in the pretest and post-test and trace the changes due to instruction.

Findings from our study show that the particular problem requirements encouraged students to express their reasoning in their own words and hence, enhance and develop deeper understanding. The participants significantly improved, deepened their understanding and could better solve familiar and unfamiliar problems by using the same mathematical tools. Also, students reported that working on such format problems was a very meaningful process for them resulting to coherent understanding. However, some of these problems challenged even the most highly motivated and highest achieving students. Evidence also provides insight into the importance of instructor training.

Keywords: physics teacher education, mathematics in physics, physics education,

European Benchmarks for Physics Teachíng Degrees

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The network STEPS TWO [1], sponsored by the European Union, has studied several aspects of physics teaching in Europe. In the last year, the main topic was the education of physics teachers. In this context, a task force* formulated a proposal for European benchmarks, i.e., specifications of minimum qualifications (knowledge and skills) that should be possessed by students as they finish their initial training and enter the school system, possibly in a provisionary capacity. They are similar in spirit to descriptions of physics bachelor, master and doctoral degrees published recently by the European Physical Society [2].

As school systems and systems of teacher education differ widely throughout Europe, we concentrated on teachers for upper secondary school and on schools preparing their pupils for university studies, though many aspects apply to other teachers as well. Also because of this diversity, we did not deem it feasible to formulate separate benchmarks for the bachelor and master stages. Our proposal was based on the curricula and qualification profiles of universities participating in the project, as well as on national studies, notably the one issued by the German Physical Society (DPG) [3].

According to our proposal, physics teachers should have completed an academic education, preferably on the master level, comprising Physics, the Teaching (Didactics) of Physics and Applied Pedagogy; the programme should be research based in all three components. Where national law or usage require it, they may also qualify in a second subject and its didactics,

The benchmarks contain a listing of competences in Physics, Physics Teaching and Applied Pedagogy, as well as social competences. They also contain a core curriculum in Physics (including auxiliary mathematics) and Physics Teaching. Care was taken not to be overly prescriptive: only broad ranges are given for the number of credits to be earned in the various subfields of physics, and actual curricula should cover some subjects in more depth and contain additional, elective subjects from physics or related fields. We found the benchmarks are basically fulfillesd by the curricula offered by most universities in the network.

Benchmarks of this type could be useful for the design and development of teacher education programmes, both regular ones ans special ones aimed, e.g., at scientists or engineers without pedagogical training wishing to enter the teaching profession. They could also play a role in quality assurance for such programmes. In countries with a severe shortage of qualified physics teachers, where some lessons are given on an emergency basis by teachers who are not fully qualified, they might help in designing in-service education programmes allowing such teachers to obtain a fuller qualification. As standards of this type emerge, they might also help in easing the international mobility of physics teachers.

In my presentation I shall present the latest version of proposal and the reasoning behind it, and invite comments that can be incorporated in an improved version to be submitted to national physical societies and organizations of physics teachers for their comments and endorsement.

*The task force consisted of: Ovidiu Caltun (Iasi), Eamonn Cunningham (Dublin), Gerrit Kuik and Ed van den Berg (Amsterdam), Marisa Michelini (Udine), Gorazd Planinsic (Ljubljana), Elena Sassi (Naples), Rita van Peteghem (Antwerpen), Frank J. van Steenwijk (Groningen), Urbaan M. Titulaer (Linz, Chair) and Vaggelis Vitoratos (Patras).

[1] For further information on the network see http://www.stepstwo.eu.
[2] See http://www.eps.org/?page=studies_reports.
[3] An English version can be found at http://dpg-physik.de/veroeffentlichung/broschueren/studien/lehramt-eng_2010.pdf.

Keywords: physics teacher education, benchmarks, competencies, core curriculum, in-service education

PS.09.06.b

Strand 8: Initial Physics Teacher Education

Parallel Session 09.06
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: FAZIL SAY (Auditorium II)

Effects of Modeling on Argumentative Discourse

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Introduction and Purpose of the Study

Current research indicates that learning how to engage in productive scientific argumentation to propose and justify an explanation through argument is difficult for students (Sampson & Clark, 2008). Various studies aimed to improve students' argumentation skills and used some strategies to increase quality of their arguments. Some of those strategies are scaffolding (Bell, 2002; Yeh, 1998), writing (Voss & Means, 1991), utilizing video coaches (Crossa, Taasoobshirazib, Hendricksc & Hickeya, 2008), and using authentic problems (Patronis, Potari, & Spiliotopoulou, 1999).

The purpose of this study was to examine the effects of modeling on students' argumentation skills.

Theoretical Framework

In order to involve with scientific argumentation and produce quality arguments, students need to learn more about the types of claims that scientists make, how scientists advance them, what kinds of evidence are needed to warrant one idea over another, and how that evidence can be gathered and interpreted in terms of community standards (Kelly & Chen, 1999). Since models are essential as both content products of science (Gilbert & Osborne, 1980) and in the process of coming to understand the world scientifically (Crawford & Cullin, 2003), it is argued that model-building can be a useful tool to facilitate argumentative discourse. Therefore, this study suggests model-based teaching as an environment that provides an opportunity for students to engage in argumentative discourse.

Methodology

Experimental design with qualitative methods guided to the research. The study took place in the methods course. The population of the course was 24 pre-service physics teachers. They took the course as two equal classes. One was the control class and the other one was the experimental class. The classes were assigned randomly. Three groups from each class were selected for this study.

The argumentative intervention lasted seven weeks. Both classes engaged in argumentation but experimental class argued through model-based teaching sequences. The subjects of the argumentations were related to the Moon and lunar phenomena some of which were about the moon phases, seeing the same face of the Moon, daytime moon, lunar eclipse, rise and set times of the Moon, and location of the full moon. The participants were assigned for moon observations and moon records two months prior to the argumentative intervention to recognize the phenomena asked in the questions and to have some observable data. The participants engaged in argumentations as groups, and then whole class argumentations were carried out. The member number in each group was three. Additionally, the participants were required to write their ideas with the reasons in their worksheets individually during the group works and the whole class argumentations. The pre-service teachers in the experimental class were asked to construct three-dimensional models. At the first week of the intervention, the groups discussed and decided how their model would be. At the second week, they came to the class with their initial models. They argued with their models, found the strengths and weaknesses as their models were used to explain the phenomena and revised their models throughout the interventions.

Both classes were videotaped during their involvements with the argumentations. Data for this research were collected via video recordings and written arguments. Comparisons were made within as well as between the groups' first and last weeks' argumentations. The participants discussed moonrise, moonset, and seeing the same face of the Moon in the first week and appearance of the Earth from the Moon in the last week.

The participants' argumentations were analyzed based on the combinational framework constructed by the authors according to McNeill (2006)'s and Sampson (2007)'s works. The framework consisted of the following argument components: claim, data, and reasoning. A scoring rubric was developed and each component was evaluated out of four points. Claims were evaluated according to their internal consistency, completeness, and accuracy. Data were evaluated according to their relevancy with the claims, accuracy, and appropriateness. Criteria used in evaluation of reasoning were relationship between the claim and the data, adequacy of the explanation made for why the data supported the claim, and existence of a warrant or a qualifier. The participants' argumentation points were composed of the sum of the points given to their claims, data, and reasoning.

Results

The three groups from the experimental class were named as Group A, Group B, and Group C. The three groups from the control class were named as Group D, Group E, and Group F. In total, the experimental class produced more arguments than control class from the beginning to the end. Group A increased their overall argumentation points and the number of arguments they produced from the first week to the last week. The reason for this increase might be their concrete model which represented real situations quite well. On the other hand, Group B and Group C decreased their points and the number of arguments from the first week to the last week. Their premature models might cause this result because they could not discuss how astronaut would see the Earth from the Moon by using their models. As far as the control class is concerned, their overall argumentation points and the number of arguments they produced increased from the first week to the last week. This finding is expected because research shows that argumentation quality improves as the participants involve in argumentation more and spend more time in arguing (Author, 2012).

Conclusion and Implication of the Study:

Construction of concrete models and using them in their discussions and explanations provide pre-service teachers with more quality argumentations. In addition, models' quality affects the accuracy, consistency, appropriateness, and relevancy of their arguments. This study has implication by showing the relationship between modeling and argumentative discourse.

Keywords: modeling, argumentation

PS.09.06.c

Strand 8: Initial Physics Teacher Education

Parallel Session 09.06

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: FAZIL SAY (Auditorium II)

Lesson Practices by Pre-service Teachers in the Distinguished Science Teacher Project

Fumiko Okiharu, Akizo Kobayashi
Niigata University

In order to strengthen scientific teaching ability in elementary school and junior high school, the distinguished science teacher project were developed in our university in 2010. Our main purpose of pre-service teacher training were to deepen students' knowledge of subject beyond their speciality and to develop ICT-based scientific teaching abilities. We take advantage of our developed Active-Learning Systems in physics1) for this pre-service teacher training.

One of characteristics in our teacher training is lesson practices by pre-service teachers (undergraduate, graduate students) at the junior high school. In general lesson practice, each individual pre-service teacher is assigned to a class, and he/she must organize a class alone. However, in this project a class is made by all pre-service teachers through one month discussion, development of teaching materials and several trail lessons at the university. One pre-service teacher conducts a class, while others support him/her as TAs in classroom. We had ten times lesson practices during 2010-2011 and four of them were physics. We introduce our lesson practices of mechanics, wave nature of light. In mechanics, junior high school students were already studies in the topics, velocity and acceleration and so on, but less experimental experiences. In order to deeper understanding of time-variable nature of motion, motion sensors were effectively applied. For wave nature of light, though it is out of curriculum in junior high school, one of pre-service teacher insisted it should be scientific literacy to be learn at the compulsory education stage. Therefore, we chose familiar topic for junior high school students, why sky is blue and sunset is red. In the class, she taught elementary spectroscopy and scattering with various experiments. At the end of class, we always have one hour discussion with junior high school teachers about the class. And also we got feedback from students by questionnaire investigation.

At the presentation, we discuss how effective these lesson practices for developing pre-service teachers ability of teaching physics and learn physics deeply.

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Keywords: Teacher Training, Lesson Practices, ICT

PS.09.06.d

Strand 8: Initial Physics Teacher Education

Parallel Session 09.06

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: FAZIL SAY (Auditorium II)

Linking the in-service teacher education programme to the practical work of upper secondary physics students

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Practical work is central to the learning of physics and that it is a source of many difficulties to students has been extensively documented in literature. Research findings confirm that the key factor in determining student performance is teacher competencies and there is, however, less research on how teachers learn the different roles of practical work in their teacher education programmes.

This research has been prompted by poor student achievement as reported by Cambridge International Examinations in ordinary and advanced level practical physics over a number of years in Mauritius. The need for the study was argued from a review of literature which brought to notice the scarce research in understanding the impact of the in-service teacher education programme in one developing country, Mauritius, on practical work in physics. In particular, we investigate the outcome and evaluate the efficacy of the teacher education programme on the learning experiences and performance of upper secondary students in practical work.

The subject groups of the study were practising physics teachers and upper secondary students of physics. A sample of thirty-five practising physics teachers who followed the in-service post graduate certificate in education (science with physics) participated in the study. Data were collected about the curriculum of the programme and the perceptions of teachers about the effectiveness of the programme. The teachers were tested on their physics pedagogical content knowledge. The empirical study was also conducted by observing practical sessions conducted by the secondary school teachers. The data sets also came from laboratory videos of physics students at work in traditional laboratory classes and through the analysis of the laboratory reports of students. In-depth interviews with a selected number of students were conducted to elicit their construct of practical work and to document the issues and priorities they brought to their understanding of practical work.

The results derived from this study indicate that teachers rely heavily on recipe or cookbook laboratory work. Practical skills teaching and learning occurred without learners being actively engaged in the process. Practical work is examination oriented and there is little scope for inductive open-ended investigations. There is almost no correlation between laboratory work - which is mostly about experimental equipment and methods of handling them - and the learning of physics concepts in the classroom. The findings show that the cohort of teachers who had followed the in-service programme had sufficient knowledge of instructional and pedagogical strategies to make practical work more effective in the learning of physics. There are contextual, linguistic and social constraints and challenges to effective practical work that a more relevant and contextualised teacher curriculum can address.

This work gives a new understanding and perspectives on the link between the in-service teacher education programme and student performance and quality of work in practical physics. The challenges to developing competent physics teachers in the important role of teaching practical physics were identified. The findings demonstrate the necessity and importance of designing teacher education programmes for physics teachers with an emphasis on developing the competencies to address the school ethos and social culture.

Keywords: in-service teacher education, practical work, teacher curriculum, teacher competencies

PS.09.07.a

Strand 10: Physics Curricula

Parallel Session 09.07

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D501 (4th Floor)

Basic Principles to Understand Measurement Uncertainties in Classrooms

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Motivation. In the course of quantitative data collection in scientific experiments, capturing and discussing measurement uncertainties is essential to assess the reliability and the consequences of gained results. This is highly relevant for both research and learning in science. Due to their general inevitability it is impossible to ignore measurement uncertainties, even though it is often done so in schools. Therefore, a normative model of an adequate understanding of measurement uncertainties on secondary school level was developed, which will be presented in the talk.

Research. The findings of Séré et al. (1993), Allie et al. (1998), and Buffler et al. (2001) implicate that even first-year college students who are able to evaluate the uncertainties of their obtained data have problems to understand the underlying concepts. According to the categorization conducted by Buffler et al., the students' views can be described in means of the paradigms "point" and "set", differentiating between the perception of a single reading leading to the "true" value of a measured quantity and the more adequate concept of a measurement result as an interval of possible values to be assigned to the observed quantity.
Lubben and Millar (1996) investigated secondary school students' (aged 11 to 16) ideas concerning the reliability of experimental data and established an eight level progression model based on their findings, in which the progression from the first to the final level can be seen as a continuous shift from the "point" to the "set" paradigm. However, their research mainly focused on the perceived necessity of repeating measurements.

Open questions and aim of the project. Overall, the didactical research conducted so far concerning measurement uncertainties on school and college level seems to be dominated by a mostly descriptive approach, i.e. exploring and categorizing learners' views. Up until now though, neither standards on how and to which extend measurement uncertainties should be addressed in secondary school nor concrete expectations concerning school students' understanding of this topic are provided.
With the aim to fill this gap, we pursue the objective to develop normative guidelines containing all aspects of understanding and handling measurement uncertainties to be found relevant and comprehensible to the science classroom.

Methods. To do so, an analysis of the topic area's content and structure was performed, considering the respective national and international standards, literature and lab manuals. To be mentioned in particular are the "Guide to the Expression of measurement Uncertainty in Measurement (GUM)" released by the International Organization for Standardization (ISO) and course manuals developed by Buffler et al. (2008).
The findings of this analysis were validated through interviews with six experts such as textbook authors and members of corresponding national institutions (e.g. the German Institute for Standardization).
The subsequent reduction of this model to secondary school level was supported by an online survey with 108 physics teachers in total.

Results. This strategy led to an extensive and profound content structure model that is comprised of four dimensions: (1) "Existence of Uncertainties as Basic Principle", (2) "Uncertainties' Influence on a Measurement", (3) "Evaluation of Uncertainties", and (4) "Conclusiveness of Uncertainties". Each dimension includes basic concepts that only require simple mathematical methods on secondary school level. The talk will focus on outlining this horizon of expectation and giving exemplary illustrations of the appertaining concepts.

Outlook. This model could lay the foundation for the design of corresponding curricula, learning environments, and test instruments to facilitate a systematic and correct approach to measurement uncertainties in school.

Keywords: Measurement Uncertainties, Curriculum Development

PS.09.07.b

Strand 10: Physics Curricula

Parallel Session 09.07

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D501 (4th Floor)

A View of Integrated Non-Chronological Physics: From the micro to the macro, from the macro to the micro - linking the dimensions

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This paper presents a theoretical reflection about the structure of the physics curriculum in middle schools in Brazil. When we analyze the organization of the topics of physics textbooks for middle Brazilian schools, we find a certain uniformity in the organization of the topics taught. Even in the most modern organizations, where we can find topics about the modern physics, it seems the contents are in a kind of chronological organization. In general, the textbook collections are divided into three volumes. The first is the study of classical mechanics. The second one is about thermodynamics, geometric optics, and wave motion and oscillation. And the last volume focuses on electromagnetism and modern physics. However, our goal isn't to review the textbooks of Brazil, but rather to propose the building of a different curriculum of physics for middle schools whose approach is not chronological. We take the point of view that physics is a symbolic representation of reality (Ernest Cassirer – The Philosophy of Symbolic Form), and as such is one of mediation between man and the world. It starts from the pictorial representation of a spiral, whose starting point is the elementary particles and whose goal is the cosmos, the galaxies. Specifically, this spiral shape is manifested in the reappearance of elements at the various hierarchical levels that compose the representation of the world that is important for us. Between the microcosmos and the macrocosmos appears the mesocosmos, the scale of man, who manifests as the author of the process of the construction of scientific knowledge. So let us think of Physics in an integrated manner, making use of current issues which are related to human activities. This perspective clarifies the teaching of the subject and turns students into citizens able to engage and transform society. More than proposing the building of a different curriculum of physics for middle schools, the present work, through pictorial representation where each representation present in the spiral was built from the perspective of The Philosophy of Symbolic Form, can be a great tool to let us reflect about issues related to physics teaching.

Keywords: Physics Curriculum, Physics Teaching, Symbolic Form, Philosophy of Science.

PS.09.07.c

Strand 10: Physics Curricula

Parallel Session 09.07

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D501 (4th Floor)

Reconsidering some aspects of Inquiry Based Science Education: a case study on Model Based Inquiry

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In the last years many international research projects focused on Inquiry Based Science Education (IBSE) have been developed. They are aimed at engaging learners and teachers not only with content but also with the epistemic practices of authentic science. The related research reports have confirmed that Inquiry Based Science curricula can improve independent and critical thinking skills, positive attitudes and curiosity toward science and increased achievement in disciplines, like physics, chemistry and biology, that are traditionally considered "difficult" to learn. Another noticeable result of these projects has been the highlighting of some misconceptions about IBSE retained by the people involved in it, as teachers and, in some cases, researchers. In particular, we cite the ideas that:

• Inquiry-Based Instruction is a mere application of the "scientific method";

• Inquiry-Based Instruction can be implemented simply through the use of hands-on activities and educational kits;

• the simple interest generated by hands-on activities and peer to peer student work ensures a better learning of the science concepts involved.

Research has shown that in Inquiry-Based Instruction there is more than the simple application of scientific laboratory methods and that a form of inquiry deeply focused on generation, testing and revision of scientific models (Model Based Inquiry, MBI) can support a profound learning at all level of instruction. In particular, it has been shown that inquiry activities based on the construction of explicative models, i.e. on the proposal of scientific situations to be explained by means of a "functioning method", can have as a consequence real inquiry teaching and learning.

In this paper we will report about a research involving Engineering freshmen at University of Palermo. The effects on the development of explicative competences in students obtained through a 20 hour course focused on MBI in physics are analyzed. The results of a pre-test and of a post-test, analyzed by means of quantitative analysis methods will be discussed, together with qualitative data coming from interviews with a selected sample of students that have participated to the course. The use of quantitative/qualitative data analysis allowed us to classify the students into three 'profiles' related to different approaches to the idea of model, and to show the implications of the different conceptual strategies used to answer the pre/post test questionnaires, giving an estimation of the classification/implication 'strength'. Some hints on how a course for university student education can be planned in order to orient the students to the construction of models of explanation are reported.

Keywords: Inquiry Based Science Education, IBSE, Model Based Inquiry, MBI, quantitative analysis, qualitative analysis, explicative models

PS.09.07.d

Strand 10: Physics Curricula

Parallel Session 09.07
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D501 (4th Floor)

Spiral Physics Active-Learning Workbooks

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Spiral Physics is a physics education research-inspired introductory physics curriculum.

The development of Spiral Physics was motivated by the belief that the traditional linear sequence of topics in introductory physics discourages understanding of the hierarchical nature and the interconnectedness of physics knowledge. In Spiral Physics topics are sequenced so that students get repeated, or spiral, exposure to the same concepts throughout the course as they investigate increasingly more complex models of the physical world. This repeated exposure to incrementally more complex topics makes evident the coherent knowledge structure of physics, allows rapid assimilation of new concepts as the course progresses, and encourages development of more mature and expert-like problem-solving skills.

Additionally, the integrated text and workbook materials of Spiral Physics are designed to be employed in a studio setting, and foster active learning and model-based problem solving through a near exclusive use of alternative problem-solving tasks. Alternative tasks, designed to replace traditional end-of-chapter problems, emphasize multiple-representation problem solving, which requires students to construct multiple representations of a physical situation before, and sometimes instead of, constructing a mathematical representation (i.e., applying formulas). These alternative tasks increase understanding of the underlying physics of the situation as well as making the models ultimately employed more robust.

Another novel feature of Spiral Physics is the use of goal-free problems. The goal of solving introductory physics problems is to help students develop the ability to create and manipulate models of physical situations. Unfortunately, traditional end-of-chapter problems encourage the view that the goal of solving problems is the determination of the numerical value of the specified target variable. This disconnect is because typical end-of chapter problems encourage (and many textbooks and student solution manuals explicitly endorse) the use of means-ends analysis as a problem-solving strategy. However, according to cognitive load theory, mental effort is a limited resource and means-ends analysis requires a relatively large amount of cognitive processing capacity. As such, students may successfully complete the task and learn nothing from it because all available mental effort was used to complete the task and none was available for learning from the task. In a goal-free problem, students are presented with a description of a physical situation and told that their task is to construct a complete model of the situation, rather than calculate a prescribed numerical goal. Then, using this model, students are instructed to determine everything that can reasonably be determined about the situation. Before deciding on what values to find, and what equations to use, the students must figure out what is happening in the situation, what physically important quantities are relevant, and what basic physics principles need to be modeled.

Spiral Physics has been in use at Monroe Community College (Rochester, NY, USA) and other colleges since 1994. Assessment of Spiral Physics implementations via the FCI, MBT, CSEM, and MPEX compare favorably with results reported in the literature. The workbooks are freely available for local adaptation and use at http://web.monroecc.edu/spiral/

Keywords: active learning, problem-solving, introductory physics

PS.09.08.W

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 09.08 Workshop

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D502 (4th Floor)

Modellus: A tool for interactive mathematical modelling

Rui Gomes Neves, Vítor Duarte Teodoro

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For modern professional communities that research in or apply physics and mathematics it is clear that the development of knowledge in these fields involves interactive modelling processes that balance different theoretical, experimental and computational elements. To appropriately reflect such range of epistemological characteristics should thus be a fundamental goal of curricula and learning environments for physics and mathematics education. Many research efforts (see, e.g., McDermott & Redish, 1999; Slooten, van den Berg & Ellermeijer, 2006) have already been able to show that the learning processes in various areas of science, technology, engineering and mathematics can effectively be enhanced when students are embedded in atmospheres with activities that approximately recreate the cognitive involvement of scientists in modelling research actions. An essential aspect of these approaches, particularly in physics and mathematics, is to achieve an early integration of activities that make an ample use of computational knowledge and technologies. However, even in technologically advanced countries, computer based methods and tools are still far from being appropriately integrated in most curricula and learning environments, where their use is largely limited to the display of text, images or simulations.

This problem arises because to integrate computational knowledge and technologies and produce measurable learning gains is a difficult curricular and technological challenge. Indeed, in spite of the significant progress made over the years, using professional programming languages (see, e.g., Chabay & Sherwood, 2008) or scientific computation software such as Mathematica or Matlab requires that students develop a working knowledge of programming, a fact that inevitably turns out to generate additional learning difficulties which, for the majority of students, can hinder the process of learning physics and mathematics. To reduce the amount of programming and focus the learning activities on the concepts of physics and mathematics, several computer modelling systems have been developed (see, e.g., Christian & Esquembre, 2007; Heck, Kadzierska & Ellermeijer, 2009; Teodoro & Neves, 2011; Wieman, Perkins & Adams, 2008).

This workshop introduces participants to Modellus (Teodoro & Neves, 2011), a research based domain general environment for mathematical modelling which allows the design of interactive learning activities that span the range of different kinds of modelling from explorative to expressive modelling. As a mathematical modelling tool Modellus advantages stem from the following main functionalities: 1) Easy and intuitive creation of mathematical models using standard mathematical notation; 2) The possibility to create animations with interactive objects that have mathematical properties expressed in the model; 3) The simultaneous exploration of multiple representations such as images, tables, graphs and animations; and 4) The computation and display of mathematical quantities obtained from the analysis of images and graphs. Workshop participants will have the opportunity to engage in the creation of a selection of interactive computational modelling activities that can be used to support curricula where students from the age of 12 to introductory university years can explore advanced mathematical and physical reasoning applying simple scientific computation methods. As resource materials digital PDF documents which present the activities using interactive text, images or movies, and include free working space to insert multimedia enriched notes, will be distributed. Participants are recommended to bring their own computer notebooks, if possible with Java, Acrobat Reader and Quick Time pre-installed.

The workshop is intended for an audience of physics and mathematics teachers and researchers interested in computational modelling educational resources for secondary and introductory university levels.

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Keywords: physics and mathematics education; computational modelling; interactive simulations; secondary and university education

PS.09.09.W

Strand 2: Teaching Physics Concepts

Parallel Session 09.09 Workshop
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D504 (4th Floor)

Materials from the Contemporary Physics Education Project that can be used to enhance physics classes

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The Contemporary Physics Education Project (CPEP) is a nonprofit organization founded almost 25 years ago to produce charts and other materials exhibiting areas of ongoing physics research in colorful fashion. The charts are field tested extensively before their release. This workshop will feature the current charts, written support materials, and internet-based support materials. Suggestions for how physics teachers might use the charts and other materials in their classrooms will be discussed. The Standard Model chart of Fundamental Interactions and Particle Physics was the first chart from CPEP, and the one that has seen the greatest number of changes. We discuss how this chart can be used not only to bring interest to the classroom but also how it can be used to teach particle physics. The chart is complemented by the Particle Adventure, which is based on the web and accessible in many languages. Fusion makes the stars glow and the H-bomb. What is it that causes fusion in the Sun and makes it so hard to get fusion on Earth? The Fusion and Plasma Physics Chart from the CPEP helps students find some answers. FusEdWeb is based on the web and is accessible in several languages. The Nuclear Science chart from CPEP helps students find some answers about the chart of the nuclides and radioactive decay. It also presents them with cutting-edge nuclear physics, such an investigation of quark-gluon plasmas. The chart is complemented by ABCs of Nuclear Science, which is based on the web. The History and Fate of the Universe chart from CPEP helps students find some answers to the questions we have about where we've been and where we're going. The chart is complemented by The Universe Adventure, which is based on the web and accessible in several languages.

Keywords: contemporary physics, Standard Model, particle physics, cosmology, fusion, plasma physics, nuclear physics

PS.09.10.W

Strand 3: Learning Physics Concepts

Parallel Session 09.10 Workshop
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D505 (4th Floor)

MUSE workshop Session 1 Colour phenomena: the role of absorption

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Target audience (about 20): physics teachers and teacher educators at any school level.
The main objective is to highlight the design of educational activities around simple experiments that would be necessary in order to go beyond invoking mere excitement, and would aim at maximizing students' conceptual understanding. To this end, the workshop will illustrate the "MUSE" approach (an EPS-PED project: http://education.epsdivisions.org/muse/).
The main idea is that, simple to perform as they may be, many experiments with ready-made materials deserve detailed reflection if they are to be used as a focal point for promoting meaningful learning.
During each session of the workshop, we will present an example of a "simple" experiment in order to engage the participants in discussion around the key ideas of the MUSE process:
- the need for conducting an in depth-content analysis in direct comparison with students' common ideas and difficulties;
- the importance of reflective awareness of teaching rituals and the shortcomings involved in constraining teaching to routines without resorting to careful and specialized design;
- the educational value of elaborating conceptual links both within and between activities, as well as with situations from everyday life.

Workshop Outline:
-Brief introduction to present the MUSE core ideas (about 10 min)
-The participants will be invited into a series of activities bearing on Colour and Absorption (about 50 min). These activities will be carried out in five small groups that will work in parallel on the same tasks
-The first set of activities will act as a brief reminder of the classical rules of colour mixing.
-The core of the workshop will be leading participants to go beyond a blind acceptation of classical rules. This will be done through observations of a very "simple" experiment, easy to reproduce, that often turns out to be thought provoking. Important conceptual steps will be involved in the discussion.
- A whole group discussion (about 25 min), in order to share the experiences gained in the small groups, and envisage the transfer of the workshop to different audiences (students, teacher educators).
All participants will receive detailed documents for this experiment, including sheets directly usable in the class or to be adapted to different contexts.

A very important contribution from Gorazd Planinsic is gratefully acknowledged.

References:
Ten free-downloadable documents at: http://education.epsdivisions.org/muse/, including:
Sassi, E., Planinšič, G., Ucke, C. & Viennot, L. 2011. Added Value in Education.
Planinšič, G. & Viennot, L. 2010. Shadows: stories of light..
Viennot & de Hosson, 2012. Colour phenomena and partial absorption

Keywords: Conceptual learning, simple experiments, teacher education, colour, absorption

Mathematical challenges to secondary school students and teachers in a guided reinvention, context-based teaching-learning strategy towards the concept of energy conservation

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Guiding 16-year-old students to rediscover the concept of energy conservation can be done in several, distinct steps.
First we make sure that students need special cases of the energy conservation law to solve various technological design problems. From experiments intended by the students to solve these problems they can rediscover the special cases of energy conservation (Logman et al., 2010) (e.g. $\sum(m \cdot g \cdot h) = k1$ or any equivalent to explain an easy solution to lifting a cap stone on top of pillars in ancient Greece, or $\sum(m \cdot c \cdot T) = k2$ or any equivalent to explain a solution to mixing hot and cold water to a desired temperature in a new design thermostatic water tap).
Next, to broaden the applicability of these laws, the students are asked within a scientific context to combine the rediscovered partial energy conservation laws into a more general energy conservation law (Logman et al., 2011) (e.g. combining $\sum(m \cdot g \cdot h) = k1$ with $\sum(m \cdot c \cdot T) = k2$ into $\sum(m \cdot g \cdot h) + \sum(m \cdot c \cdot T) = k3$ making the new law also applicable to a combined domain in which both h and T vary).
Finally students are asked to extrapolate their combining skills to give statements about how many storage forms of energy may be added in a similar way to generalize the energy conservation law as much as possible and whether it is always possible to perform such a generalization whenever conservation appears to be violated. This again is set within a scientific context.
In the first two parts we have uncovered mathematically challenging steps which remain obscure in more traditional teachings of the concept of energy conservation. As the sequence is an innovative teaching-learning strategy teachers are not well equipped to guide the students along as well.
The first mathematical challenge lies in retrieving a physical law from measured data (specifically in retrieving a physical law involving squares or square roots like $m.g.h + ½ \cdot m \cdot v2 = k4$ or equivalent).
The second challenge lies in combining the special cases of energy conservation into a more widely applicable case of energy conservation. In mathematics students are used to the fact that after multiplication and addition constants remain constant. In combining $\sum(m \cdot g \cdot h) = k1$ with $\sum(m \cdot c \cdot T) = k2$ into $\sum(m \cdot g \cdot h) + \sum(m \cdot c \cdot T) = k3$ however we perform a slightly different mathematical operation. Besides that it is hard for students to differentiate between this operation and a similar but again different mathematical operation when we combine $p \cdot V = k5$ with $V/T = k6$ into $p \cdot V/T = k7$ when broadening the applicability of special cases of the ideal gas law. In this paper we will exemplify these mathematical problems for both student and teacher and give some possible solutions for teachers to guide students in passing these obstacles.
At least partially these steps clarify the abstractness of the concept of energy and contribute to explain problems students are having in understanding this concept. Problems that do not immediately become clear in more traditional teachings.

References
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Motivating students to perform an experiment in technological design contexts. GIREP-EPEC 2011, Jyväskylä, Finland.

Keywords: mathematical challenges, energy, guided reinvention, context-based, energy conservation, ideal gas law, secondary school, teaching-learning strategy

PS.09.11.b

Strand 2: Teaching Physics Concepts

Parallel Session 09.11

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D506 (4th Floor)

Teaching energy sources and energy production possibilities at school system in Hungary

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Humans need energy for their life. Population of the world has already exceeded 7 billion. Parallel with increasing number of population energy demand of the human civilization around the world is also growing steeply. The steep gradient of the growth is started to dominate mainly in the last fifty years. Above all, these are unquestionable facts shown by many scientific and industrial data and accepted by scientists and politicians as well. The growing energy demand can only be satisfied by increasing energy production. Consequently, these issues are crucially important in the European Union (EU) and at other regions of the world. Due to the importance of the question mentioned above education of energy production, their possibilities and problematic factors must play important role in the educational structures of a country.

As well known, energy production possibilities based on types of energy sources can be divided into three main parts. First part is energy production based on fossil energy (non-renewable) sources. Second part is primer, but non-fossil sources such as nuclear energy. Third ones are all others, or in other words energy production based on non-fossil and non-nuclear energy sources. They lasts are the clearly renewable sources.

Cognition of these systems can be started in the first years of the primary schools. In the upper years knowledge can be improved step by step or year by year. Aims of the applied pedagogy at the primary schools may be the familiarization of the most important energy sources and energy production possibilities. "Talking about the topic." or "Pre-motivation" – may be the keywords here. At the secondary schools, aims of the pedagogy change. Parallel to the deeper familiarization motivation may play important role. During the years of secondary schools students must be motivated for knowing energy sources, energy production, energy demand, energy saving and problematic factors of this field. Educator has main role and possibility piquing the interest during these years or launching young energy specialists on the way. Later at colleges or universities these motivated young women or men will study deep energy engineering or power engineering. In the future just these young peoples may solve problems around energy sources and production. Why is it needed for us? Because, humans need and will need energy for their life.

This publication may try to give insight into teaching this topic in Hungarian schools. The paper tries to show: nowadays, how to teach energy sources and energy production at school structure in Hungary. In other words, the publication will try to introduce main steps of the education of the energy sources and production at primary-, secondary schools – as places of pre-studies for universities of technology – in Hungary. Besides, it is not a question that the topic is important at the national educational plan and the scientific education, too.

Keywords: education, energy sources, energy production, technology

PS.09.11.c

Strand 7: University Physics

Parallel Session 09.11

Date & Time: 05.07.2012 / 10:30 - 12:00

Room: D506 (4th Floor)

Student interpretations of visual and spatial information and the impact of learning physics and space science

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This paper will examine how student interpretations of visual and spatial information influence their learning of concepts in physics and space science. Those fields contain many concepts where spatial information is crucial to understanding. Spatial, and sometimes temporal, information is often conveyed through diagrams and other representations. These visual representations are created by experts, and are self evident to the experts, but they are vulnerable to misunderstanding by novice students. For example, among a recently surveyed group of junior and senior STEM majors who viewed X-ray images of the Sun, we documented a number of misconceptions. One third of the students referred to the bright spots on the image as "solar flares", even though no flares were present at the time. This indicates that student prior knowledge (many have heard of solar flares) can be activated inappropriately when presented with a marginally unfamiliar image. Beyond simply misunderstanding images, if an image requires significant mental manipulation in order to understand a concept or solve a problem, the mental manipulation (such as image rotation) produces cognitive load in the student and can thus inhibit learning or lead to incorrect solutions to problems. We will provide evidence of this in the context of understanding the magnetic field of a complex electrical current system. Specifically, when presented with a 2-dimensional drawing of the circuit, students had difficulty determining the three dimensional magnetic field associated with the circuit. However, when provided with an interactive 3-dimentional representation (even in perspective, without true stereo) students were much better able to apply the Biot-Savart Law and understand the geometry of the magnetic field. This issue was the cognitive load imposed by manipulation of mental images and not a lack of understanding of the appropriate physics principles. These examples will highlight the need to attend to visual and spatial issues that are separate from conceptual issues in physics, but which may also be significant impediments to learning or using physics concepts.

Keywords: Spatial and Visual cognition, cognitive load

PS.09.11.d
Strand 2: Teaching Physics Concepts
Parallel Session 09.11
Date & Time: 05.07.2012 / 10:30 - 12:00
Room: D506 (4th Floor)

Revisiting the definition of energy

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A certain consensus is growing in the science teacher's community toward the early and informal introduction of the so called primary physical quantities. They are energy and the "conjugated variables" of the classical thermodynamics, the extensive (former "exchange") variables and the intensive (former "contact") variables, reasonably renamed "quantities" and "intensities". At the beginner's level energy is introduced with the question: What have in common hot water, electricity, oil …? The relation between the flow of these substances (reasonably renamed "energy carriers") and energy is established with the rule: energy never flows alone. This leaves energy as the only "idea" between many "things", and I believe it to be important to supply from the beginning some kind of definition of energy, although during the learning process the "things" become formalized physical quantities, that is "ideas", and energy conversely an important "thing" in the real world. Moreover, because I believe the proposed definition applies to all levels of the physical discourse, I'll formulate it using terms from the common language.

Taking on the sharing argument, the definition comes from the comparison of the energy carriers, the idea which fruitfully substitutes the ambiguous "transformations of energy". Think of a process during which electricity and heat both flow in and out of a physical system. For example a Peltier module, now considered as a device which compares electricity and heat. This triggers ancient bans because we are dealing with the so called "incommensurable quantities".
Well, the comparison is made possible by the discovery – invention of energy, a function of electricity and heat which completely characterizes the physical system under consideration, precisely mapping the possible exchanges and equivalences. Like what happened in primary school when the discovery – invention of the broader "class" of fruits permitted the forbidden comparison of apples with pears, under the category of "equivalence".

Two features of the proposed approach are worth emphasizing. First the theoretical settlement which can be considered a simplified version of the general dynamics approach of classical thermodynamics. The set of the energy carriers is shown to be a righteous equivalence class, following the mathematical rules for equivalence, from which the definition of energy is firmly grounded, as the quantity discovered – invented to compare the quantities exchanged between physical systems. Second the way demonstration experiments, both qualitative and quantitative, are easily implemented in the didactic practice. Chains of energy transfer experiments, with the same final output, enable to ground the relation between the intensity of the carrier current, the driving difference of the physical process, and the intensity of the energy current, as we have seen in many examples of the recent literature on experiments.

Keywords: Energy teaching, Equivalence, Energy transformations

P2.G01.01
Strand 1: ICT and Multi-Media in Physics Education
Poster Session - 2.01
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Explaining by panes (XBP): how the Supporting Physics Teaching Initiative uses a graphical language to communicate physics multi-modally with multi-media

Ian Lawrence
Institute of Physics, UK

This poster will show a technique for representing arguments graphically used in the Supporting Physics Teaching (SPT) initiative from the Institute of Physics, as interactive diagrams.
These diagrams are not simulations or animations, although facets may sometimes seem to overlap. They are certainly not computational models, although they do often contain (invisible) computations which accurately represent the physics. Rather they are a multimodal act of communication, a graphical language embedded in a particular narrative about physics. This narrative is concerned to make explicit the consequences of lines of reasoning, rather than simply make nice moving pictures that may mimic other representations we make of the physical world. This consistent language is an ongoing attempt to show the coherence of physics (diagrams bridge words and mathematics, with affordances that are somewhere between the two in terms of precision and clarity of expression). These goals are enabled by having a consistent and rich set of representations, with the visual relationships between these representations proving clues as to the deeper physical connections between the quantities and entities represented. (For example, we don't just make do with one style of arrow, we have a whole family of arrows, with carefully chosen styles.)
The visual language is extended into providing opportunities to show how physics works by generalising across many different arguments to make explicit the kinds of steps made. This is only possible if we can abstract, to see the structure of the argument revealed. The containers for the interactive diagrams make this possible. The interactive diagrams are embedded in a consistent set of panes, representing steps in an argument, and a small set of transitions between panes. These transitions provide the glue that hold together the (often many) steps in developing an line of thought in physics. These panes and transitions are designed to work together with the ability to zoom in and out of the panes to allow learners to keep their place in the argument.(This is not so easy: in an unfamiliar landscape questions such as ’What am I doing now?’, ’What can I do next?’, ’Where am I up to in the argument?’ can be very disorientating.) Through the use of a pervasive visual language we also hope to enable discussion of, and expose the kinds of arguments used in what are typically multistep arguments in developing physics with learners.
So this is an extensive piece of development work, building on the significant investment in representing arguments using diagrams deployed in Advancing Physics and on earlier iterations of SPT materials, together with extensive field research of the state of the art in presenting arguments diagrammatically, and some serious reading on what it is to explain in the sciences and also research into what it is to communicate in a multimodal way. The current version of the language has been in the field for over a year, across two very different topics (SPT: Radiations and radiating and SPT: Electricity and energy). These topics, together with the other topics in the series, are available from TalkPhysics.org.
The poster will show extensive examples of the language in action, and explicate its semiotics.

Keywords: Physics concepts, graphical representation, multimodal communication, PCK, CPD, How Physics works

P2.G01.02
Strand 1: ICT and Multi-Media in Physics Education
Poster Session - 2.01
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Physics Teaching with Multi-Touching Tablets

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Multi-touch sensing systems started to be applied to education only within the past few years. Multi-touch screen is a device which can simultaneously receive multiple inputs from single user or multiple users. Compared to the traditional blackboards or other single-user displays, multi-touch devices (e.g., tabletops, board, tablets) are found promoting students' learning through group collaboration, virtual learning or 3D spatial Orientation. Different learning activities or concepts can be reinforced through students' interaction with the multi-touch devices. The feature of input-out unification not only helps teachers to demonstrate the abstract concepts which are used to be the constraints in traditional teaching, but also enable students to manipulate virtual experiments.
In order to improve the quality of middle-school physics courses, we developed a teacher education course called Teaching Methods in Physics and a series of multi-touch learning software. The course "Teaching Methods in Physics" was offered for senior students from the Department of Physics in a teacher college in Taiwan. It was a three-hour weekly, one-semester mandatory course. In order to be capable of using multi-touch tablets, each of the pre-service teachers was also provided with a multi-touch tablet during the semester. A series of multi-touch android apps were developed and presented during the course. The simulation software cannot only be used as these pre-service teachers' future teaching resources, but also give them ideas to design software for the topics they feel appropriate to be presented with multi-touch tablets. What really important is not what tools were being used, but how the tools were used by teacher and/or students. We will demo and illustrate how those apps can be used for conceptual physics teaching and learning.

Keywords: multi-touch tablets, physics teaching, conceptual learning

P2.G01.03
Strand 1: ICT and Multi-Media in Physics Education
Poster Session - 2.01
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Scientix: the new internet-based community for science education in europe

Carlos Jorge Cunha[1], Eloise Gérard[2], Àgueda Grás Velázquez[2]
[1]Escola secundária dom manuel martins
[2]European schoolnet

The objectives of the Lisbon declaration (2000) and the affirmation of the European Commission that there is a need to promote more widely inquiry based science education methodologies in primary and secondary schools and to support teachers' networks (2007), were the basis for launch by European Schoolnet (EUN) of Scientix, a new web-based information platform for science education in Europe. Its aim is to ensure the regular dissemination and sharing of progress, know-how, and best practices in the field of science education and providing a feedback mechanism.
Scientix is a three-year project run by EUN since December 2009 on behalf of the European Commission Directorate - General for Research and Innovation and is funded under the 7th Framework Programme. The portal (http://scientix.eu), available in six European languages, offers a resource repository containing hundreds of teaching materials from European projects, but also research reports and policy-making documents; a translation on demand service for the teaching materials towards any of the 23 languages of the European Union; a community including a forum and chat rooms; an online news service featuring international science education topics and a calendar of forthcoming events and training opportunities; and also a newsletter sent once a month to registered users. The portal allows for interaction among the registered users in the public profiles directory and for searching, commenting and rating the resources.
The Scientix main targets are teachers, providing teaching materials, scientific support and documentation that are able to give them some quality tools for the development and implementation of inquiry based science education teaching methodologies.
Besides the website, several events and workshops are being organized across Europe to disseminate the portal's tools and services. Newsletters and workshops aim to inform science teachers, explain them how to make the best use of the Scientix platform in class and also give them the opportunity to meet other European science and maths teachers.An example of this was the Scientix European Conference that took place in Brussels from 6 to 8 of May 2011, which had the participation of around 400 teachers and education staff from 37 countries.

Keywords: Scientix, DG Research, European Schoolnet, science education, teaching materials, community for science education in Europe, physics resources

P2.G01.04
Strand 1: ICT and Multi-Media in Physics Education
Poster Session - 2.01
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Generic test and item analysis for digital assessments

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Osplan Foundation (Stichting Osplan)

Automatic digital assessment gradually finds its way into Physics teaching: Conceptual understanding can be tested by choosing from a finite set of answer alternatives, for example, in ranking tasks or with questions based on interactive multimedia. It is even possible to organize classical calculus based problems on-line by using scanners and supervised peer assessment during computer-supported collaborative learning, CSCL. An implementation of such techniques is readily available in popular content management systems like Moodle or Blackboard. However, some work still needs to be done regarding the quality management of the pool of test items an instructor builds up over the years: Which of the questions are too difficult, too easy, or do not contribute consistently to the total test scores? Which answer alternatives were popular among otherwise high or low performing test takers?
The OSplan Foundation is developing a generic item analysis tool to parse results submitted in many different file formats, even spread sheets of scores filled in by hand. The goal is a uniform interpretation of test results that gives instructors more insight in their testing efforts – with or without help from dedicated psychometric consultants. As of March 2012, the analysis of Blackboard result files has been implemented in a functional alpha version. We also attempt a direct comparison with the item analysis by QuestionMark Perception assessment software. Another feature under development is the interactive assignment of grades to intervals of raw scores in various ways, and even after having dropped problematic items ex post.
This poster presentation invites interested institutions to collaborate on this small scale development in any meaningful direction, such as new result file formats, more features, or translation to other languages than English. The analysis of uploaded test result files will be offered as a free web service. The server-side source code will be available to all committed partners for installation on their own servers – which is recommended for both performance and privacy reasons! The OSplan Foundation (Dutch: Stichting OSplan, www.osplan.net) is a small non-commercial undertaking to promote the use of open source software in Science Education. Rather than selling a product, collaboration is intended to be on the basis of small projects covering the costs to reach common educational goals in specific settings.

Keywords: digital assessment, test analysis, item analysis, psychometrics, grading, web service

P2.G01.06

Strand 2: Teaching Physics Concepts

Poster Session - 2.01

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

From teachers' eyes: physics subjects that are difficult to teach and learn

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The aim of this study is to determine the difficult physics subjects to teach and learn in secondary curriculum physics units. In this research we designed and used a questionnaire entitled "A survey of physics teachers' views about physics subjects which are difficult to teach and learn (Difficult Physics Subjects Questionnaire: DPSQ)" for data collection. The questionnaire was administrated to 45 in-service physics teachers. The questionnaire consists of two parts. The first part of the questionnaire includes 7 questions physics teachers' demographic characteristics. In the second part of the questionnaire titles of the 9-12 grade units are given. Physics teachers expressed their views about these units using a 5 point Likert scale: (1) Very Difficult, (2) Difficult, (3) Moderately Difficult, (4) Little Difficult, (5) Not Difficult. Expert views provided the structural validity of the final questionnaire before it was administered to the participants. In addition, three open ended questions were asked to physics teachers in order to identify the units that students find difficult to learn. We asked the reasons for why students find these units difficult and what can be done to improve students' achievement in these units. The aim of these questions were to collect more detailed data from the participants, since qualitative research must show sufficient detail for the reader in order to be able to see the case clearly and to make sense of the researcher's conclusion.
Descriptive statistics, frequency, and percentages were calculated in the analysis of the collected data. Content analysis was conducted on the open ended questions transcripts. The main purpose of the content analysis was to identify the explanation of concepts and relationships from the data. The data were first transcribed and categorized into codes. These codes were then clustered into concepts. Once all the data were examined, the concepts are organized by the themes. Iteration between data, concepts and themes ended when enough categories were defined to describe teachers' views about subjects difficult to teach and learn. Data analysis show the most difficult physics units to teach and learn is 9th grade electricity, 10th grade modern physics, 11th grade waves and 12th grade atoms to quarks. In open ended questions, physics teachers were asked why their students thought these units were difficult to learn and why they think these units are difficult to teach. From the answers of the teachers we set codes. The codes created 5 categories about the student's reasons to strain the difficult units. Also the teachers were asked what could be done to increase students' physics course success in these difficult units. From the answers of the teachers we set codes and created 4 categories of suggested solutions to address the students' difficulties with these difficult units. The themes were divided in to two categories; one of them is "Reasons for Difficulties" the other is "Recommendations for Solution". The categories of reasons for difficulties themes as follows; negative influence of lacking appropriate mathematical background on learning physics, the abstract nature of physics subjects, students' attitudes towards physics subjects, inappropriate teaching environment and shortage of teaching materials, inadequate student background knowledge. The categories of recommendations for solution themes as follows; abstract subjects need to be taught in a core concrete way, physics course hours need to be increased, the subjects of math and physics courses need to be taught in a parallel, class size need to be reduced.

Keywords: in-service physics teachers, physics subjects, teach, learn

P2.G02.01
Strand 3: Learning Physics Concepts
Poster Session - 2.02
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Developing a diagnostic instrument to investigate undergraduate students' misconceptions of primary nanoscale science

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In a highly technological society, citizens need to make sense of scientific advances and make decision about social issues. Nanoscale science is an emerging domain and is applied to create new products and technologies. Nanoscale is generally defined as the scale of length. Various conceptions about nanoscale are related to natural phenomena. However, in Taiwan, the high school curriculum does not contain nanoscale science. Most undergraduate students without majoring in science and technology do not understand nanoscale science. They formed various misconceptions of nanoscale science from their experience. These misconceptions bring about great learning difficulties. In order to enhance students' understandings about nanoscale science, exploring their ideas and designing appropriate learning activities are required urgently. The purpose of this article was to investigate students' misconceptions of primary nanoscale science. The objects were 31 undergraduate students who majored in physical education from one national university. The open-ended questionnaire was developed to ask them describe what nanometer means and explain what lotus effect, gecko's foot and sea turtle's migration is. All students were also interviewed to illustrate their ideas. Both qualitative and quantitative research methods were taken. Descriptive statistics was used to present the percentage of correctness. Open coding was adopted to form categories and assertions. It was found that a large number of students held misconceptions of nanoscale science. Only 9.7% of students can indicate nanometer is the unit of length. Many students (about 30%) thought nanometer is tiny particle or structure. Half of them indicated that lotus effect is due to its smooth surface. More than 65% of students believed gecko crawls on the wall by its suction hook. 25.8% of students thought sea turtle relies on ocean current to distinguish direction and migrates. Only 16% of students refer to the magnetic field, but they cannot explain the mechanism. The major part of the students did not know the definition of nanometer and the life experience about nanoscale. They cannot explain the principle and lack qualitative understanding even if they use the terminology. If the knowledge of nanoscale science is necessary and desired for students, we should examine and revise our science curriculum.

Keywords: misconception; nanoscale science; undergraduate student

P2.G02.02
Strand 3: Learning Physics Concepts
Poster Session - 2.02
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Hands-on supporting students in understanding the process of vision

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The objective of this contribution is to present simple hands-on experiments that support students in understanding the process of vision within the field of geometrical optics. Students' ideas of vision have been investigated thoroughly over the last decades. Research has repeatedly shown that students bring several categories of alternative conceptions concerning the process of vision to their physics lessons (Duit 2009). Guesne (1985) has classified the most frequently held conceptions of students into four main categories: the light bath, the illumination of an object, the active eye and the physicists' model, which is based on a mechanism that links the object with the eye, light being a mediator between them.
Research, however, also shows that conventional instruction is usually not successful in transforming these conceptions into adequate physics concepts about vision (Andersson and Kärrqvist 1983, Fetherstonhaugh et al. 1987, Langley et al. 1997, Heywood 2005, Chu et al. 2009). Several reasons can be named for the persistence of alternative conceptions about vision: One reason seems to be that students have only rarely the experience of "total darkness", so to speak the experience of total absence of light. What they conceptualize as "darkness" is in fact the absence of a direct light source but the presence of scattered light. So students deduce from their everyday experiences that they can see even when it's "dark". This frequently implies for students that light entering the eye is not a necessary condition for vision.
Another reason seems to be rooted in traditional instruction of optics itself. It looks that the concept of vision is frequently treated in a superficial way. We found hints supporting this assumption when analysing Austrian schoolbooks as well as in a survey asking Austrian high school teachers' (N=22) about central concepts for teaching optics (Haagen-Schützenhöfer and Hopf, 2011).
Generally, school books can be seen as a good predictor for the concepts teachers base their lessons on. Many (Austrian) text-books do not pay attention to the process of vision or just summarize it superficially at the beginning of the chapter on geometrical optics. A similar situation holds true for the idea that objects – whether light sources or not – can give off light under certain circumstances. The concept of seeing objects because they scatter light is frequently neglected. Similar results were achieved when asking teachers for the importance of the concepts of vision and scattering of light in optics lessons.
In order to support students in constructing an appropriate concept of vision we developed a number of hands on and tried them out with students. One approach to promote the understanding of vision was to create a learning environment that makes students familiar with the experience of "total darkness". Usually it is quite tricky to create "total darkness" in class rooms. Additionally, it is not always easy to handle a class of teenagers in total darkness. Considering this, our objective was to develop a hands-on experiment that can be easily constructed and is simple to handle in class.
Finally we came up with a metal tube intersected by a red and with striped stick. One end of the tube is closed firmly. Above the intersected striped stick, there is a small hole in the metal tube. When you look through the open end of the tube, you can see the intersected stick and its red and white stripes. When the small hole above the intersected stick is covered for example by putting a piece of paper above it, you can perceive the stripes of the intersected stick only as different shades of grey. As soon as the hole is firmly covered, e.g. by pressing a finger against it, no light can enter the tube. As a consequence, no light is scattered by the intersected stick and the stick can not be seen anymore.
This and other simple hands-on focusing on the vision of objects were tried out with students at different age levels. In most cases teaching was based on the POE (Predict – Observe – Explain) structure. The analyses of the output of this teaching experiments show that the hands-on supported students in understanding the process of vision.
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Keywords: Geometrical optics, hands-on, foster conceputal understanding of the process of vision, geometrical optics for beginners

P2.G02.03

Strand 3: Learning Physics Concepts

Poster Session - 2.02

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Improving scientific knowledge and laboratory skills of secondary school students: the Italian Plan "Scientific Degrees"

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The activities organized by the Department of Physics of Naples University "Federico II" in the framework of the Italian National Plan "Piano Lauree Scientifiche (PLS, Plan for University Scientific Degrees, http://www.progettolaureescientifiche.eu/)" are discussed. PLS, established since 2005 by the Ministry of Education, University, Research, addresses the decreased enrolment of students in tertiary scientific education and aims at a deeper scientific knowledge of students and teachers. To inform about employment possibilities in industry the Italian National Board of Industries participates to PLS. The involved University degrees are: Chemistry, Mathematics, Physics and Materials Sciences. The main objectives are to: improve knowledge on Science contents and Nature of Science through laboratory activities; enrich in-service teachers' competences on lab-work; help students be more aware of both, their own knowledge about scientific contents and the pre-requisites of University curricula; deepen specific Science topics for the most motivated students; improve teacher's education. Nationally, in 2005-2009, PLS has involved 38 Universities, 3000 Schools and 4000 school Teachers; in the Naples area 40 schools, 60 teachers and 1000 students have participated to PLS-Physics.

In 2010-2011, the experimental activities of PLS-Physics Naples were mainly performed in the involved schools' laboratories (16 - 20 hours for each school), also to help teachers become more familiar with school-lab equipments. Five schools, eight physics teachers and eighty students participated to these activities. The first one addressed scientific notation, significant figures, uncertainties and their propagation, data fitting and modelling. The second and third activities dealt with two experiments chosen out of the lab-work of the first two years of the Physics degree. Examples of measurements are: elastic constant of a metallic spring (by Hooke' law and oscillation period); gravity acceleration by a simple pendulum; temperature vs. time trend of an hot-water mass cooling in a constant temperature environment; hair thickness using diffraction pattern of a laser beam. As fourth activity, the measure of the electron charge to mass ratio, via the magnetic deflection of an electrons' beam across Lorentz' coils, was done at the Department of Physics. In an Active-Learning approach students made measurements and data analysis in small groups (4-5) to benefit also from peer-learning. The teachers enriched their competences; to increase the impact of PLS-Physics they were asked to disseminate the performed experiments in their schools. A three-days Master-Class about particle physics involved the most motivated students and teachers. At the end of the school year, a full-day workshop with all students and teachers involved in PLS was held at the University; various groups of students presented a talk on a performed experiment. Later in two seminars, the participating teachers shared, with colleagues of other schools, their experience and ideas for improving students' participation. The PLS-Physics activities have been positively evaluated by students and teachers.

In 2012 the participating schools are eight, for a total of about 130 students. For the first time some primary schools classes (9-10 and 7-8 years old pupils) have experienced lab-work at the University, showing remarkable scientific ideas and reasoning.

Keywords: national plan, physics knowledge, secondary school, teacher education

P2.G02.04
Strand 3: Learning Physics Concepts
Poster Session - 2.02
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Beyond simplistic conceptual change: Learning electric circuit theory as the "learning of a complex concept"

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In education research it is common to investigate students' "misconceptions" about "single concepts". However, when we analysed engineering students' learning during a course on electric circuit theory, we found that examining student learning in terms of "single concepts" was not sufficient. As a result, the notion that learning should be seen as the learning of a complex concept, i.e. a "concept" that makes up a holistic system of "single" interrelated "concepts" (a whole made up of interrelated parts) emerges.
In our model "single concepts" are illustrated as nodes or "islands" that may be connected by arrows representing the links actually make (representing the lived object of learning, i.e. what the students have learned). The nodes ("single concepts") in our model can be found empirically, using data such as video-recordings, by looking for "gaps" (Wickman, 2004) in the actions and dialogue by students. A gap corresponds to a link that has not been established, and an established link corresponds to a gap that is filled. This methodology is a further development of Wickman's practical epistemologies, which were based on Wittgenstein's philosophy of language. Similarly the links students are supposed to make (identified by analysing the intended object of learning) can be represented using our model.
The idea behind our model is that knowledge is holistic. Knowledge is built by learning the component pieces, the "islands", as well as by learning the whole object of learning through making explicit links. Hence, the more links that are made, the more complete the knowledge becomes.
In this study we report an analysis of a sequence of labs concerning AC-electricity and concerning transient response in an electric circuit theory course. Our results show that student learning of "electricity" could be analysed as a learning of a complex concept. Furthermore, according to our analysis "entities" that were separate in the earlier labs were fused into one in later labs. For example in a later lab we could note that "the physical circuit" and "the circuit drawing" had fused into a single "real circuit". Our results suggest that the learning of a complex concept first starts with establishing more and more links. As links become well established, "entities" that have been separate fuse into a whole.
Our model suggests a method for finding "learning difficulties" since these correspond to "gaps" and non-established links. As teachers and experts in a field we can miss to uncover these since for us the 'complex concept' has become a conceptual whole and we may no longer be able to distinguish the parts in the complex unless we investigate how students fill or fail to fill gaps. Furthermore it is important to note that we have analysed the use of concepts, models, representations and experimental equipment; this is seen as integrated aspect of learning a complex concept. Hence, we did not study, or attempt to draw any conclusions about students' eventual mental models. We studied what students do.

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Keywords: Conceptual understanding, conceptual change, complex concepts, learning

P2.G02.05

Strand 3: Learning Physics Concepts

Poster Session - 2.02

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

A qualitative investigation of high school students' misconceptions and learning difficulties of free fall motion

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The present study is a qualitative research which is about the high school students' knowledge of the free fall subject and its related topics. We will analyze the free fall from 4 different aspects: 1) the students' preconceptions of this concept 2) some of the students' misconceptions of this concept and it's reasons 3) prerequisites that are necessary for learning this concept 4) suggestions to improve the quality of the instruction.
This study is a survey about the student's understanding of the free fall motion after the traditional instruction. The results of this study will be discussed as a means for developing the physics curriculum.
A problems that we face with among the high school students is their misconceptions. Specially in their physic course as some of the physics rules do not match with our experimental observations.Diagnosing the preconceptions of the students helps us to make effective instructional materials to overcome the students' learning difficulties.
We mostly emphasize on solving numerical questions instead of paying attention to fundamental concepts. This is a real problem in our books that can automatically effects on teachers approach. For example concepts like force, field and energy are never considered by the teachers, however, several formulas along with numerical questions are observed in the books.
The free fall motion is one of those concepts that face with some problems from different aspects including both learning and teaching.
Here we name some of these problems:
*The free fall word exists in the students' daily lives so they have preconceptions of this word on their minds.
*There are some misconceptions about its related concepts on the students' minds. (EX: faster free fall of the heavier substance).
*It contains phenomena that do not match with the students' minds (ex: the simultaneous free fall of the coin and feather)
* We don't prepare the students by necessary prerequisites for learning the subject. (Ex: the air resistance topic and vacuum)
In the present study we are going to explain some of the common problems about the learning of the free fall concept and present several suggestions to solve these problems.
Reasons of the study:
After the common teaching of the free fall subject to tenth and twelfth grade, we can observe that many students, who are able to handle the mathematical algorithms well, do not have a good conceptual understanding of the subject. To overcome this lack of understanding, the instructional approach should be able to consider the special difficulties of the students.A proper qualitative study can discover these problems and find a good solution.
It seems that some of the students' problems which is about this subject, is due to the books that contents are not rich enough.
To analyze the difficulties of the students, regarding to the precious guides of my respectful professor Dr.Vesali and my teaching experiences, I prepared the students (Nasabe high school in Darab city) with a questionnaire which contained 5 conceptual questions. The questionnaires were given to 70 students of twelfth level, after traditional teaching of free fall.
After analyzing the answers, we found out, unlike the students were able to solve the most complex numerical questions, they didn't have a good understanding of the free fall subject.some problems are:
1) A few number of the students are able to present a proper definition of the free fall motion.(Only 9 students (%12) were able to present a proper definition referring to the weight force.)
2) The free fall word application in the real life causes misconception on the students' minds. some of them (19 students (%27)) think that the free fall motion simply happens when we drop or throw something just downward.
3) The vacuum concept is not still clear for the students and some of them think that vacuum happens when air and gravity doesn't exist.(20 students (%28) believe that in the vacuum condition we have no air and no gravity.13 students (%18) think that vacuum condition happens when there is no gravity regardless of air existence.)
4) The students don't have a good understanding of the force concept. They think that if we throw an object up, our hands force is saved inside the object. The object is affected by both our hand's force and the gravity, while it is moving upward.(30 students (%43) believe that the object is affected by both hand force and the gravity force.)
5) This Aristotle point of view (A heavier object falls faster) is match with their daily experiences and it's like a belief in their lives.(48 students (%69) believe that the coin is heavier so it's affected by the gravity more

than the feather. So, it falls down more quickly.)
6) The air resistant subject (what exactly the air resistant is and how it effects on an object falling, how we can reduce it and what will happen if it doesn't exist) Is still unclear for students and it should be discussed more.
7) The students don't have a good understanding of the vacuum concept so it's not easy for them to understand the differences between falling in the vacuum and in air.(19 students (%27) explained that the two objects fall down at the same time as we don't have any gravity in the vacuum condition.)

CONCLUSION:
According to the results of the present study, it's very important for us to pay attention to the fundamental concepts more than before. Also it's better to teach necessary subjects like vacuum and the air resistant before teaching the free fall concepts. It's also helpful to give the students a summary of the Galileo's activity and his mental experiment of free fall. Also, some video clips about the simultaneous free fall of the feather and the coin is also useful.

Keywords: free fall, preconception, misconception, vacuum, the air resistant force

P2.G02.07

Strand 3: Learning Physics Concepts

Poster Session - 2.02

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

A didactic proposal for wave optics learning

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A didactic proposal consisting of a sequence of theoretical-experimental group activities designed to introduce university students of the first courses to the fundamental concepts of wave optics is presented in this paper. Each activity aims at discussing some of the concepts that constitute the wave optics model and the limits of validity of such model.

The proposal is based on the Vergnaud´s conceptual fields theory, which postulates that concepts, procedures and symbolic representations are connected and linked with each other during the process of knowledge acquisition. Vergnaud (1990) believes that concepts acquire meaning through multiple situations and problems, when the subject gradually selects relevant properties to constitute the concepts-in-action and the theorems-in-action. In this process, the linguistic expressions, symbols and symbolic representations help the subject achieve cognitive complexity. With respect to this, a detailed study of the field of knowledge provides the teacher with a picture of the many operative invariants with which a given task may be sorted out and the possible operative invariants the student might use during the process of learning.

The sequence of activities that integrates the proposal is also based on the results of previous research on the causes of students´ difficulties in learning wave optics (Maurines 2010; Colin and Viennot 2002; Ambrose 1999; Wosilait et.al. 1999). Three types of activities are proposed:

-Introductory activities: they consist of a series of qualitative exercises of pencil and paper where some of the most common symbolic representations of a wave are used. One of the activities makes use of an analogy, the interference of waves in water, to discuss the phenomenon of the interference of luminous waves of two point sources that emit in phase and at the same frequency. The activity is also based on the use of diagrams of concentric circles drawn in acetate, representing the wave fronts emitted by a luminous source. The superposition of the diagrams permits to analyze the formation of lines of interference maxima and minima in the space surrounding two sources that emit in phase and at the same frequency, and the dependence of the lines of maxima and minima on the separation between the sources.

The objective of the introductory activities is to generate a group discussion about the questions posed in order to make explicit some fundamental concepts of wave movement such as: wave phase, phase difference between two waves, wavelength, electric field intensity at different points of the plane at a particular instant of time or at a point of the plane at different times, wave front, wave superposition and interference pattern. Moreover, the sequence of questions helps the teacher acting as guide to lead the students´ reasoning towards the conditions required to reach the interference pattern stability in space and in time, as a first approach to the concepts of temporal coherence and spatial coherence.

-Prediction activities: students are asked to predict what would be observed on the screen in an experimental system consisting of a light source, a double-slit system (or a single slit system) and a white screen, when the source is on. Two alternatives for the source are considered: the use of a laser beam and an ordinary incandescent lamp. This stage aims at making evident the students´ operative invariants and their conceptions of the behavior of radiation since, within the theoretical framework underlying the proposal, they are considered to be key elements for the achievement of the new concepts.

-Experimental activities: these activities involve the observation of the diffraction and interference patterns by means of the experimental system presented in this paper, and the experimental study of the qualitative dependence of the patterns on aperture width, distance between slits and wavelength of the incident radiation, as well as the measurement of the laser wavelength using single slits, double- slit systems and/or diffraction networks.

The initial stage of the experimental activities is one of confrontation with experience and in some cases of conflict as well. This works as a motivating factor, leading the students to question the limits of validity of their pre-scientific models and to compare them with the capability of the scientific ones. Indeed, most of the students are surprised by the contradiction arisen between their predictions and the experimental results. The main contradictions are generated by the incorrect use of the geometrical optics model and the lack of differentiation between the different features of the laser (bandwidth, coherence length and coherence time) and those of the ordinary sources of light.

The results of the proposal implementation show that:

- The construction of a new paradigm, the wave optics, is a slow and complex process.
- The sequence of activities continuously leading the students from the situations to the analysis of concepts and symbolic representations, and vice versa, permits the progressive construction of the electromagnetic wave concept to account for the interference and diffraction phenomena.
- Experimental activities in small groups represent a significant didactic strategy in the process of conceptualization of the topic, since it involves a working environment favorable for the students to make explicit their operative invariants and models, as well as for discussion and meaning negotiation. The activities contribute to the conceptualization of the wave model of light as they foster awareness of the

different magnitudes of the variables involved, such as the slit separation and width, the laser wavelength and the angles of different intensity maxima and minima on the screen, thus affording inferences and predictions as regards the behavior of the distinct experimental systems. The discussion on the limits of validity of the model that explains the experimental results is also favored by providing quantitative criteria to analyze the model's validity. The hypotheses that are tested in the proposal are great distance to the screen and small angles.

Keywords: conceptualization, interference of light waves, conceptual fields theory

P2.G02.08

Strand 3: Learning Physics Concepts

Poster Session - 2.02

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Secondary School Students' Explanations on Anomalous Data in Real Experiments and Computer Simulations

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Theoretical Background and Motivation of the Study

It is one approach in physics instruction to shatter students' preconceptions with experiments that trigger unexpected observations, which are in contrast to their initial hypotheses or preconceptions. This can cause cognitive conflicts, which are widely considered to be an opportunity to induce dissatisfaction, and therefore are a first requirement to accomplish conceptual change (e.g., Posner, Strike, Hewson and Gertzog, 1982). However, research has shown that learners struggle with rejecting their initial hypothesis or concepts, despite occurring contradictions in experimental data (e.g., Chinn & Brewer, 1998; Kanari & Millar, 2004; Schulz, Goodman, Tenenbaum & Jenkins, 2008). It is well known that (but not why) students tend to maintain their hypothesis and favor experimental data that confirms these preconceptions (Joolingen & de Jong, 1997). In this context, Chinn and Brewer (1993; 1998) proposed an eight-stage taxonomy of responses to anomalous data. These responses were gained through paper-pencil-tests and then subsequently evaluated. Experimental data was more propounded than self-collected, so that we argue the transferability into real physics classes. Additional to that many studies regarding inquiry learning and experimentation were carried out in computer-simulated environments only (e.g. Njoo & de Jong, 1993; de Jong & van Joolingen, 1998; Künsting, Wirth & Paas, 2010). We challenge these results because in these studies the process of experimentation is often reduced to an inadequate minimum. Furthermore, we assume that virtual experiments suggest a higher assurance in the data-evaluation process. From an epistemological point of view this would be very ambiguous. Hence, the purpose of this study was to contribute to the understanding of students' behavior, assessment and reasoning in different experimental situations, more precisely in experiments with contradictory data.

Research Questions

Our work was underlying the following research questions:

1. Do both experimental setups (virtual vs. real) equally promote students to change their initial hypothesis in the face of contradictory data?
2. Which explanations are given for and against holding and discarding of self-constructed hypotheses?

Methods

In contrast to the work of Chinn and Brewer (1998), a special focus is put on the self-construction of the initial hypothesis and the independently running experimentation and data evaluation process. The task was to give an initial hypothesis about the relation between the mass of a pendulum and its period of oscillation. This context allows the participants to generate a subjectively plausible hypothesis out of everyday-life experiences. Afterwards the students were asked to examine their hypothesis by collecting experimental data in a real, hands-on experimental setup or a virtual computer simulation. We set great value upon the identical setup of the experimental settings. Both provide the same experiment space. To collect a wide spectrum of given reasons and argumentations the participants were interviewed in a half-structured interview. The study was carried out in a randomized, experimental design in secondary schools during 2011 with n=81 participants, divided into two groups (virtual and real experimental setup).

Results

Corresponding to Kanari and Miller (2004) more than 81% of the participants have chosen an incorrect initial hypothesis in the beginning (i.e. 'the heavier the mass of the pendulum the longer it takes to oscillate'). As a first result, it is remarkable that both hands-on (n=32) and computer experiments (n=34) promoted the participants to switch from a wrong hypothesis to the right one after the experiment equally ($\chi^2(1)$ =.273; ns). Students´ explanations for holding and discarding of hypotheses gained in the interviews were qualitatively categorized into eight groups, which might be divided into two levels of explanation depending on the emotional or rational reaction to the anomalous data. The affective level includes Ignoring the Data, Intuitive Questioning, Confirmation by Experts, Appreciation caused by Authority. The rational level includes Reasoning by Evidence, Measurement Uncertainties, Questioning of Experimental Setup or Competence. For example, the explanation "I seem to remember that the time [of swing] stayed equal. But my gut feeling says that if the pendulum mass is bigger, it swings longer!" as an argumentation for a wrong hypothesis in the face of contradictory data was matched to the category "Intuitive Questioning".

Discussion

It is quite remarkable that this dichotomous allocation seems to be very similar to the Elaboration-Likelihood-Model of Persuasion (ELM, Petty & Cacioppo 1986). The ELM is a model of how attitudes are changed and formed under the influence of a persuasive message and provides two routes to persuasion. The central route describes how one can evaluate a message logically, so that it requires extensive cognitive processing. The elaboration of the message via the peripheral route mainly focuses on the environmental characteristics of the message (credibility, the way the message is presented etc.). It seems very plausible to link the levels of explanation in our study to the routes described by the ELM. The affective level conforms to the peripheral route, whereas the rational level is modeled by the central route in the ELM. The ELM names several requirements for the choice of the route, i.e. motivational aspects, relevance or the students' need for cognition. If this assumption is proven, it will have wide implications, as the main goal should be to promote students to use the central route to elaborate experimental data, not the peripheral route.

Outlook

Up until now, our first results have to be considered in a rather hypothetical way, but we are encouraged to proceed with our work and to investigate how one can harness the ELM in science classes. In currently ongoing and more in-depth studies we further examine the durability of hypotheses change induced by contradictory experiments depending on the setup (real vs. virtual).

Keywords: conceptual change, anomalous data, reasoning from data, computer simulations, real experiments, students' explanations, hypotheses,

P2.G03.01

Strand 4: Laboratory Activities in Physics Education

Poster Session - 2.03

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Connecting Coach equipment to Easy Java Simulations models

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Easy Java Simulations (EJS) is a modeling and authoring tool that allows easy creation of interactive graphical simulations in Java for non-expert programmers. As such, it is been successfully used by physics instructors world-wide to create simulations for instructional purposes. See http://www.um.es/fem/EjsWiki.
One of the most interesting expansion possibilities of EJS is through the relatively new "Model Element" concept. Model elements allow advanced programmers to facilitate the use of their generic Java libraries to the less sophisticated programmers who use EJS.
In this work we show new model elements for EJS that we have created to allow easy connection of EJS models to Coach equipment. CoachLab interface is an affordable hardware interface, distributed by the Dutch CMA company, which offers the possibility to measure and control with a computer. CoachLab is connected to the PC via the USB port and powered via a mains adapter. CMA also offers cheap sensors and actuators that can be connected to the CoachLab interface for the actual measuring and control, thus allowing the creation of an easy to use, multifunctional laboratory. See http://cma-science.nl/english/hardware/006plus.html.
However, so far, the use of Coach equipment was strongly tied to the software platform created and sold by the CMA company, which runs only under the Windows operating system. Our new model element (and the underlying library) allows the use of Coach in any Java powered computer. We have dealt with the internal complexities of programming the communication from Java to the CoachLab interface, and reduced it to the simple gesture of dragging an icon (the model element) and invoking a few Java methods to communicate to it from within the modeling code. Furthermore, the combination of the new model elements with the modeling capabilities of EJS allows EJS users to create laboratory simulations that combine computational models with real data.
We show in this interactive poster how to add a Coach module, sensors, and actuators to an EJS model. We also show a complete example of a laboratory experiment where we compare theoretical output to actual sensors data.

Keywords: EJS, Coach, laboratory, experiment

P2.G03.02
Strand 4: Laboratory Activities in Physics Education
Poster Session - 2.03
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Air Table: Designing a Laboratory Set for CAL

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In physics with the experimental process, the scientific method is used and with this process we are able to understand nature. Educationalists prefer using contemporary tools like CAL(Computer Assisted Learning) to traditional tools, to acquire the attention of the students and retention of the subject learned. Some examples to computer assisted learning could be listed as equation calculations, watching demonstrations where it is hard to replicate the experiment and see the facts due to physical constraints. The other reason is CAL lessons take much shorter time than traditional ones. Hence the student is able to spend more time on understanding the current subject and cogitate on the meaning of the experiment. Thus students can develop high level skills on the subject being thought. To this extent companies producing lab equipment have begun working on ways to integrate new technologies to their products by using touch screens, helpful software and adding data analyzer connectivity. Among these lab equipment that have been so far developed the multi-functional lab equipment the "Air Table" has not received any of the attention. On a "Air Table" one can do the following experiments; basic harmonic motion, the application and observation of Newton's 2ND law using the Atwood experiment, the calculation of the gravitational acceleration, angular velocity and rotational inertia observations, velocity and acceleration observations and calculations on an angular plane, projectile motion observations and calculations, collisions and the conservation of momentum, constant acceleration and linear motion observations and calculations, inclined plane experiments, constant speed and linear motion observations and related calculations. In this research we have further developed the common "Air Table" not only by changing the hardware but also adding software that we believe will revolutionize lab studies. Our novel approach will help out the teacher to teach the content while not hindering the students' on hands learning. This research consists of redesigning the "Air Table" and writing the software for the re-designed "Air Table" and some minor issues we have overcome related to the hardware and software integration and the effects of such lab equipment on students and teachers' educational procedure, along with a proposal to further our studies.

Keywords: CAL, Computer Assisted Learning, Air Table, Lab Equipment Development

P2.G03.03x

Strand 4: Laboratory Activities in Physics Education

Poster Session - 2.03

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Science education vehicle

Vijaykumar C Verenkar
The progress high school sanquelim goa india

Science Education Vehicle is the hybridization of several similar concept such as Mobile science laboratory, Science Education On Wheels, Science Class on Wheels, Travelling Science Exibition, but with a difference. In science Education vehicle I have provided materials for different science activities which could be performed over a week in every high school.The bus is designed and fabricated considering the economy of space, ease and quick packing and unpacking.
SEV caters the need of primary secondary & higher secondary students in the state.

Objective of SEV
1. To make the children learn the basic concepts in science through simple experiments.
2. To accomplish learning by doing and experiencing the joy discovery.
3. Using ICT to explore the syllabus content live.
4. To enlightened the students with advance and frontline learning areas such as recent developments in communication system, space technology, biotechnology, health issues, energy and environment, nano technology and all other significant development. With the help of science CD's available.
5. Linking the basic concepts in science with day today life.
6. Creating scientific awaerness, temper and attitude among students youth and community.
7. To make the text book content live with the help of PP presentations and use of internet access for wider perspective of the syllabus.
In a weeks programme following programmes are organised:
1. A grand science exibition of over hundread working models in science.
2. A grad photo exibition of world scientists.
3. Use of ICT in teaching learning process.
4. Sky gazing at night with help of telescope in SEV.
5. Popular lectures by Scientists.
Science education vehicle as been sucessful project in popularisation of science in the state of Goa in India since last five years.

Keywords: Sciene Education Vehicle, Mobile Science Laboratory, Science Education on Wheels, Science class on wheels and Travelling Science Exhibition.

P2.G03.04
Strand 4: Laboratory Activities in Physics Education
Poster Session - 2.03
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Students exploring the laws of radioactivity and the math of randomness with a real remote experiment

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Experiments and ICTs are essential parts of science education. For some topics, however, there are obstacles in performing experiments. In our contribution we present a new remotely controlled experiment on radioactivity. We suggest to use it for teaching physics and statistics. It covers three physical phenomena: 1) monitoring of natural background radiation and the verification of its statistical behaviour (with the application of the Poisson distribution), 2) verification how the level of radioactivity decreases with increasing distance from a radioactive source, and 3) verification of the exponential decrease in the level of radioactivity in the dependence on the thickness of a shielding layer and its material. We exploit many advantages of real remote laboratory experiments that are available for free 24/7 to anyone at the Czech remote laboratory http://www.ises.info/index.php/en/laboratory. When nobody is logged in all the measurements are performed automatically in a cycle for larger series of data that can be downloaded and statistically processed.
A student is provided a webcam view of the experimental setup and he/she may perform time-consuming and dangerous experiments with radioactive sources stronger than ones available at schools. The measurement can be done manually or automatically according to the students‘s settings, both for small and large statistical sets of data. A student has to use statistics in order to process his/her own experimental data he/she has recorded and downloaded during the session. One can learn the importance of statistics to decide whether the theory of a stochastic process corresponds to the experimental results, considering the average values and statistical errors. Everyone’s data are unique, thus copied results may be simply revealed. The measurement in the Czech or German remote laboratory can be added some e-texts with the theory and simulations (e.g. the applet on Beta Decay from the PhET project) according to the school curriculum; we call this strategy the integrated e-learning [Schauer, Ozvoldova, Lustig: Integrated e-Learning – New Strategy of Cognition of Real World in Teaching Physics, iJOE Vol. 4, Issue 1, Feb. 2008, 52–55].
Finally we present our first experience with the use of these remote experiments at secondary schools. Students must perform the remote measurement and process their own data at home and write a report with the results, discussion and conclusion. Graphs with errorbars are required. Students state that the Poisson distribution in case 1) and the exponential dependence in case 3) fit the experimental points well. In case 2), however, the expected dependence differs a little from the measured points, which might be explained in the discussion by the geometry of the experimental setup. Students get familiar with graphical data processing and they get convinced of the effectiveness of common ways how to protect ourselves against ionizing radiation in many applications (RTG diagnostics, nuclear power plants, etc.).

Keywords: remote laboratory experiment, radioactivity, ionizing radiation, natural background radiation, Poisson distribution, statistics, integrated e-learning

P2.G03.05
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Date & Time: 05.07.2012 / 13:00 - 14:00
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Visualizing the Profile of Waves: New Experiments with the Ripple Tank

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The ripple tank is one of the physics education devices most used by teachers and is one of the most appreciated tools by students too. It allows us to visualize various phenomena related to wave physics on the water in an effective and enthralling way. Usually this apparatus consists of a tank with a transparent bottom which is filled with a thin layer of water. A source of light illuminates the water surface from the top and the water is mechanically perturbed in order to produce regular waves. With the water crests and troughs acting as converging and diverging lenses, the surface configuration is reproduced on a screen using a play of light and shade.
Here we propose a simple and cheap modification of this tool. The whole device could be constructed by students in their school laboratory and we give instructions for doing that. The lighting in our apparatus differs from the usual arrangement. The light is somewhat oblique with respect to the water surface and a system of screens with holes and slits is placed at the bottom of the glass tank. This allows us to select small portions of the water surface to be illuminated. Our modified ripple tank gives us the possibility to make some new experiments and to explain by further examples the properties of waves. For instance, on a screen we can observe the almost sinusoidal profile of a traveling wave, in order to analyze the relation between period, wavelength and speed. When we produce a wave packet, we can observe its dispersion, as its width grows and its profile changes while traveling on the water. This tool allows us also to make some considerations regarding the amplitude and intensity of diffraction and interference patterns, which are not possible with the original ripple tank.

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Keywords: Physics of Waves, Experiments with Ripple Tank

P2.G03.06
Strand 4: Laboratory Activities in Physics Education
Poster Session - 2.03
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

An alternative approach to viscometry in laboratory exercises and research

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At Czech technical universities, physics laboratory exercises are often included as a compulsory part of the offered study programs. The aim is to provide the students with practical skills supplementing the theoretical lectures on physics. Through the exercises, the students are given the opportunity to broaden their understanding of the laws of physics in terms of being able to test their validity and their limits of applicability. In the process, they learn many practical skills needed for laboratory work and improve their ability to measure fundamental physical quantities. They are required to assess the acquired data critically and to interpret them correctly including uncertainties and systematic errors.
In the first year of university, students have courses on classical mechanics, including to some extent the field of hydrodynamics. One of the key concepts in hydrodynamics is the distinction between ideal and real fluids, directly related to the physical quantity of viscosity. From our everyday experience we know that not all fluids are equally "liquid", e.g., water and air are thinner than honey or oil. This behavior is determined by viscosity, which is a very important parameter in general studies of hydrodynamics as well as in many industrial applications.
In the compulsory physics laboratories at the Faculty of Mathematics and Physics of the Charles University in Prague, which are part of the elementary course of physics in both Bachelor´s and Master´s study programs students measure viscosity using Mariotte´s bottle, falling sphere, torsional and Ubbelohde viscometers. These methods have already been known for a long time, but each of them has its limitations depending on the fluid being studied and mainly on the available volume of the sample. Accurate measurements might also be difficult because of observed deviations depending on the viscosity of the sample and on the actual setup used.
This report is concerned with the establishment viscosity using vibrating quartz tuning forks, which may be employed as sensitive detectors of the physical properties of their surroundings. The fork can be described as a mechanical/electrical linear harmonic oscillator with damping (due to an incompressible viscous Newtonian fluid). The tuning fork is excited by an AC voltage signal at a given frequency (corresponding to a driving force) and the passing current (corresponding to the velocity of oscillation) is measured by a lock-in amplifier. From the response we evaluate the fundamental resonance frequency and the linewidth (FWHM), which can be used after calibration to determine the density and viscosity of the surrounding medium.
The largest advantage of this method lies in the possibility to measure very small samples (volumes as low as 300 μl; useful for expensive samples in fundamental research), and thus to easily vary the temperature over a considerable range (150 – 400 K) limited only by the thermostat used. The tuning forks are optimally suited for measurements of fluid viscosities of about 0.01 Pa s and lower, including dilute gases at low pressures or even liquid helium at temperatures below 4.2 K, having one of the lowest viscosities of all known substances, about 10-6 Pa s. On the other hand, in highly viscous fluids (such as glycerol), where viscometers of one of the classical designs mentioned above are sufficiently accurate, the signal of the tuning fork is suppressed below measurable levels.
Two samples were used in the experiments, differing significantly by their electrical conductivity – n-hexane and de-ionized water. In insulating samples (n-hexane) we were able to attain an accuracy of 1% or better. For use in weakly conducting samples (DI water), the tuning fork had to be coated with an insulating layer (spray paint) to improve the signal to noise ratio by limiting the parasitic currents between the electrodes of the tuning fork. The applied layer significantly reduced the quality factor of the tuning fork resonance; nevertheless, an accuracy of 10% or better was attained.
In summary, we designed and constructed a new type of viscometer operating on the principle of tuning fork resonance. It enables us to measure the viscosity of very small samples over a broad range of temperatures. Subsequently, this viscometer will be included among the practical tasks of the physics student laboratories, where it will be employed to measure the viscosity of common fluids, especially for comparison with the other methods mentioned above. This type of viscometer will also be used as a complementary technique in laboratories, where expensive low-volume samples are investigated, such as in studies of transport properties of various molecular solutions by NMR.

Keywords: quartz tuning fork, viscometr, measurement of viscosity

P2.G04.01
Strand 6: Secondary School Physics
Poster Session - 2.04
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Electric circuits in The Heureka Project – multiple representations

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One of the main goals of teaching/learning physics at school should be to help students to develop their "scientific ability". This term is used for describing processes and methods that scientists use when constructing knowledge and when solving experimental problems.
The scientific ability is a very complex skill; the ability to represent information in multiple ways is one part of it.
The Rutgers Physics and Astronomy Education Research group (Eugenia Etkina, Alan Van Heuvelen and others take part in this group) shows three sub-abilities which help to make this multiple representation strategy productive for reasoning and problem solving [1]:
• The ability to correctly extract information from a representation;
• The ability to construct a new representation from another type of representation;
• The ability to evaluate the consistency of different representations and modify them when necessary.
Students could use the multiple representations in different topics - for example motion diagrams and free-body diagrams in Mechanics, ray diagrams in Optics, etc.
"The simple electric circuits" is one of traditional parts of teaching physics at lower secondary school, but sometimes the possibilities for multiple representations are missed. In our experience the topic Electricity, especially "Electric circuits" offers many possibilities for developing students' scientific ability. In The Heureka Project we have a long experience with tasks, in which students use multiple representations of electric circuits.
At the beginning students (children about 12 years old) learn how to describe the real electric circuit and its function by
• Electrical circuit diagrams
• Table, in which the function of the electric circuit could be shown, and which is shorter and simpler than verbal description

Poster will present the method, how we build the concept of electric circuits and its different representations in students' mind. We will present several concrete examples of the tasks, which are solved during the learning process and some students' solutions.

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http://paer.rutgers.edu/ScientificAbilities/The+Abilities/default.aspx

Keywords: The Heureka Project; electric circuits; multiple representations

P2.G04.02

Strand 6: Secondary School Physics

Poster Session - 2.04

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Learning colour phenomena: the effects of a teaching strategy designed to favor a change in the way of learning

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Many research works have studied ideas related to vision and the vision of colour in students of different ages. Most of them have shown that even after the formal teaching, students of different levels of education tend to explain that "we see because we have eyes" and that "the color is a characteristic of the objects". That is to say, intuitive ideas, models and conceptions are used, based on reductionist way of reasoning instead of non-systemic. As a result, these ways of explaining the phenomena are the opposite of the ones proposed by science.
Considering this situation, it is necessary to ask about the reason why students, in spite of having a formal education, seem not to learn the ideas proposed by science. Why do students have so many difficulties in building scientific models related to the visual perception phenomena? What kind of learning does the construction of these models involve?
The theoretical perspective adopted in this case implies that the scientific knowledge and the intuitive knowledge are considered as two ways of knowing, two completely different ways of "seeing" and interpreting the world that show different implicit characteristics. These differences could be related not only to the explicative model but also with the conceptual, epistemic and ontological principles that characterise each way of learning.
Learning scientific knowledge and, particularly the models proposed to explain the direct vision of an object would mean:
- To overcome naive/ingenuous realism, so as to relate intuitive ideas to the scientific ones, while identifying them as different ways of understanding the world, by means of which explanations at different levels of complexity and contextual validity can be developed.
- To overcome ontological restrictions imposed by intuitive ideas and to acquire the principles subjacent to the construction of scientific knowledge. The main problem of learning processes that need a change in the ontological categories might be due to difficulties in reinterpreting the phenomena in terms of interaction processes, as this seems to go against the intuitive tendency to understand them within the causal linear and unidirectional relations.
- To overcome the conceptual restrictions imposed by the ideas that are built intuitively and that are gradually might lead to acquire the principles implied in the building of scientific knowledge, which implies the idea of overcoming the principle of "fact or data", so as to accept interaction as a way of understanding these phenomena.
Nevertheless, how could it be possible to foster a kind of learning as the one described here? With the idea of favoring a relevant learning of the science knowledge with designed a teaching proposal which was implemented in a group of secondary school students of 13-14 years old.
In this work we studied what and how students learn, when the learning is guided through a teaching methodology specially designed for this investigation and when a traditional teaching methodology is implemented. To do this the way of knowing of the two groups of students is studied (the experimental one that learns through the designed proposal and the control one that receives traditional teaching in three stages: before the instruction, immediately after the implementation and then after three months had past since the ending of the teaching process. With this information what was analysed was the level of conceptualization that students had reached in both groups and also the influence of instruction in the experienced learning in each case.
The study was carried out with two groups of 32 and 35 students between 13 to 14 years old, in Argentina. The designed implemented was an intergroup factorial design of two, not at random groups with pretest, posttest and later tests in a quasi-controlled group. It also studied the influence (and interrelation) of the independent variables (time of instruction; teaching proposals) over the dependent variable represented by the probability with which this groups use the different conceptions.
The results obtained in the pre test stage allowed us to see that before the teaching processes were implemented, students of both groups activated ways of reasoning that we have characterized as reductionists and monovaried, not systemic. So, ontological, conceptual and epistemological principles of state, fact or data and naïve realism are associated to this way of knowing.
The new proposal helped diminish the probability with which students use intuitive ideas and helped increase the use the scientific ideas. Students ended up explaining the perceptive process in terms of abstract models and ways of reasoning characterized as pluri-varied.
Taking into account all the above mentioned, we could conclude that the new teaching proposal favoured a

change in the way of the students' knowing, from an initially intuitive one to another more coherent with the one of school science. The fostered learning was such that students, even in the later test stage, went on using the models built as the product of schooling.
Traditional teaching, however, did not foster a deep change in the way of students' knowing (and with that the underlying conceptual, epistemological and ontological principles) who, at any time, went on using mainly intuitive conceptions to explain perceptive phenomena.
The results obtained showed it is possible to foster the learning of sciences in Secondary School Education if this process is thought as a substantial change in the way of knowing, which implies the gradual step from an intuitive knowledge to another more coherent with the one of science.

Keywords: learning colour, teaching proposal, ontological change

P2.G04.03
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Poster Session - 2.04
Date & Time: 05.07.2012 / 13:00 - 14:00
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Learn Physic in secondary School, through Gesture

Giri Cahyono Mariadi
Man serpong (Serpong Islamic State Senior High School)

In secondary school in my country, sometimes physic concept is not easy to understand by student. Especially while our school facility is limited. So, I, as a physic teacher, have to do something difference to make students understand.
Based on concept of the balance of right and left brain function, I involve gesture to learn Physic. The body moving of student or some student stimulate right brain. The cooperation between right and left brain function should more easier to understand for student.
My experience, this method is running in Mechanical, Wave, electric and magnetism, Modern Physic.
The average result of this method is the student are more easier to understand the physic concept.
And the important thing is the student is convenient, happy, sweaty and more understand.
So, This method should be a good discussion for all physic teacher all over the world. Especially, while our school facility is limited.

Keywords: Learning Physic, gesture, secondary school, limited facility

P2.G04.04
Strand 6: Secondary School Physics
Poster Session - 2.04
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Students of the 21st century learning science: The use of movies to teach Physics

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Since the '60s, videos about physics have been produced. It all started when the PSSC presented its first video "Frames of Reference" that surprised, and still has amazed many people since its debut.
Few attempts appeared in the same proportion as PSSC, but they opened a new field in the media: Science Propagation.
With Carl Sagan, in the '80s, we had the series "Cosmos," which attracted the interest of several students in physics and astronomy. In the same decade there was the production of CalTech: "The Mechanical Universe". But access to those products was restricted to developed countries. In developing countries (former Third World) there were rare opportunities to access that material.
Currently, with easy access to the Internet, people can download programs produced by PBS / NOVA and the BBC and still get the subtitles in their language using free sites. In Brazil, for instance, it’s possible to buy DVDs about science at newsstands or department stores. (unfortunately, there are still only a few titles in portuguese). Some series are already available in the virtual video stores too.
The language used in DVDs and scientific programs on television is very attractive and edited carefully for this new audience: our students.
these productions are assisted by scientists. Notwithstanding, the viewers still need a theoretical support on the subjects, since the understanding of the matters requires prior knowledge about physics.
The objective of this work is to show how a successful experiment can bring the students of physics closer through a television screen or a computer.
Our experience started in a public high school in the outskirts of Rio de Janeiro, where middle and lower class students get along well. Our school has an LCD, TV, DVD player, notebook and a home theater system.
Every Tuesday and Thursday school students and their teachers get together for a movie session about physics during their lunch time, between the morning and afternoon (12am to 1pm). Interestingly enough, the videos have, in most cases, a duration of about 45 - 50 minutes. Occasionally, when the film is longer, it occurs in two or more sessions.
The films presented cover issues such as Modern Physics: Relativity, Particle Physics, String Theory, Cosmology and Astrophysics, and History and Philosophy of Science: Galileo, Kepler, Newton, Faraday, Einstein, Bohr, Heisenberg and Feynman. There are also Brazilian productions about our physicists Cesar Lattes and José Leite Lopes about our aeronautical engineer Santos Dumont, showing that science can be done by any one of our people.
Before, during and after each film, the issues are discussed with students. The teacher is the mediator of opinions and questions that may arise during the presentation of the film, indicating literature, websites and articles.
Following educator Paulo Freire’s philosophy, our proposal is to bring a more innovative language into school, with updated information which will be contextualized according to students’ realities and anxieties A liberating education can develop critical citizens in relation to their role in society, thinkers that will have autonomy to draw their own conclusions about science.

Keywords: Learning Science, Autonomy, Interdisciplinary

P2.G04.05
Strand 6: Secondary School Physics
Poster Session - 2.04
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Non-destructive methods in material science in attractive way

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Attractiveness of technical schools is quite poor in the Czech Republic. Universities with technical orientation contend with lack of students in comparison to humanities. Students consider technical branches difficult and uninteresting; however their opinion often follows from weak knowledge of these branches. They usually even don’t know what really the branches with various titles are about.
Attracting students’ interest is not an easy task. They want to know the purpose of new-gained knowledge, but answer to this demand requires explanation of all circumstances. To answer shortly and in few words is often difficult.
Material science and engineering is one of the technical branches which are faced with described students’ low interest. To increase number of students in this field, we show some parts of material physics which are generally considered as difficult; in fact they are based on basic laws and when they are explained properly, they could be understandable for everyone. Students usually know all related phenomena from their own experience but they are not able to interconnect them. Therefore, the understanding of the given topic could be difficult.
In our poster we present two non-destructive experimental techniques used for monitoring of damages in materials: acoustic emission and ultrasonic testing. Both methods are based on well-known phenomena in the nature. Nearly all damages under stress emit acoustic wave but human ears are able to register only some of them. The acoustic emission in the nature could be called as “sound of the danger”, since ice cracking, avalanches or landslips are accompanied by audible acoustic emission. Students would probably never think that this phenomenon could be used for the quality control in the technical practice or for monitoring various processes of the plastic deformation. We only have to use proper sensors to record the waves. The ultrasonic testing, which could be applied for precise characterization of damages, is based on the echo-effect, used also by flitter mice.
The explanation of the physical background of both methods is given in easy way based on high school students’ knowledge. The above mentioned simple experiments could help teachers as supplement in classes to attract students’ attention. Obviously, showing connection between common things and their usage in the technical practice is very important.

Keywords: secondary school, material science, non-destructive methods, acoustic emission, ultrasonic testing

P2.G04.06

Strand 6: Secondary School Physics

Poster Session - 2.04

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

The Italian project IDIFO3 (Innovazione Didattica in Fisica e Orientamento 3)

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The Italian main response to the fall in motivation with regard to scientific studies has been, since from 2005, the Progetto Lauree Scientifiche (PLS) (Scientific Degree Project), promoted by Science Faculties of Italian Universities and organised in the areas: mathematics, physics, chemistry, science of materials. The project PLS is financed by Ministerium for Education and University (MIUR) and coordinate 65 university local projects on mathematics, physics, chemistry and science of material. The collaboration of University with teachers in the PLS physics section is an important goal realized with different modalities.
In the context of PLS, the Italian Research Unit in Physics Education (IPERU) proposed a project coordinated by Udine University focused on Innovation in Physics Education and Vocational Guidance (IDIFO), inclusive of research based Laboratories and a Master, aimed at the in-service formation of teachers on modern physics, as a result of the carried out researches in this field. The first project IDIFO was submitted in 2006 by the University of Udine, as an initiative Promoted by 9 IPERUs. It was approved and carried out until 2008. A second edition was proposed and activated in 2009 with 15 partners. IDIFO3 biannual project starts in 2010 with 18 university partners focusing on the physics of the 20th century (quantum physics, relativity, statistical physics and science of matter) and the 'formative guidance (Problem Solving [4-5]) for teacher formation and research based inquiry laboratories The competences acquired in e-learning for teacher formation and in previous IDIFO1 and IDIFO2 [1-3] projects were the background for the bi-annual Master M-IDIFO3 of 60 cts and the Postgraduate Annual CP-IDIFO3 Course of 15cts, activated from January 2011. Eight types of activities grouped into 4 areas characterize IDIFO3 project: 1) research based explorative labs, 2) professional development of teacher in innovation for physics teaching/learning paths by means of at a distance and in presence activities, 3) informal learning in Experiments Games Ideas exhibit, 4) conceptual Labs CLOE, 5) cultural diffusion in science education using materials developed in different projects (the EU LLP project Mosem2 on superconductivity, LabGEI project in the framework of L.6/2000 for scientific dissemination, Sicuramente regional project for road safety education).
Physics Education Research is present in different dimensions in the Master IDIFO3: as a background in teacher formation models, in material used for teacher formation, in research based school experimentations (teaching experiments), in the formation processes monitored in the framework of pedagogical content knowledge (PCK) to individuate elements for a model of in-service teacher formation on modern physics [6-10]. The peculiar elements of the formative path in M-IDIFO3 are the following: a) Cultural topics relevant for teachers professional development in modern physics and formative guidance; b) mathematics and science in a new perspective for their integration, in particular looking at the role of mathematics in the main theories of the 20th century; c) ICT and new media as educational tools, for curricula innovation; d) Physics in context and communicating physics, as a context for connection of research in physics and research in physics education; e) formative guidance in Physics, having the Popular Problem Solving as reference; f) Research in physics education as base for teacher preparation; g) modular structure of the formative proposal, to offer personalization in the teacher formative path.
The activities proposed are demanding with respect to other similar formative offers. The student-teachers on the other hand proved to be highly level and deeply interested in becoming competent professionals in the treated topics. The formative Model adopted is quite effective and relevant for the needs of integration of cultural, disciplinary, teaching and professional aspects. It integrates experiential, metacultural, situated

formation offering everyone the opportunity to design development commensurate with the needs and motivations. It seems possible to conclude that the Master is an effective and flexible training method for teachers preparation to teach innovation. Last but not least the cooperation of different universities produce a rich environment for the school-university cooperation in innovation in teaching/learning physics.

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Keywords: Innovation in physics teaching and learning

P2.G05.01
Strand 9: Teacher Professional Development
Poster Session - 2.05
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Development of POCoM (Practical On-site Cooperation Model) to improve physics teaching and learning

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Many science educators have pointed out that there has been a big gap between theory and practice. That is, even though physics teachers know some teaching theories and various teaching strategies, they do not apply what they know to actual classroom/laboratory teaching. Basic goal of this study is to help physics teachers to improve their teaching by diminishing this gap. To do this, we developed POCOM (Practical On-site Cooperation Model). According to this model, professor analyzed physics teaching in classroom/laboratory by observing the class using the observational checklist developed by us, and after the class, professor discussed about how his/her teaching can be improved with teacher. Then, physics teacher tried to improve his/her teaching in the next class with the same contents for the same grade students. This cooperation was repeated 4 times during 2 days. Through this cooperation, we could observe the high level of improvement and also find out various reasons why some aspects could be improved or other aspects could not. In this presentation, we will introduce the observational checklist developed by us, and the analysis results of it. And then, we will show the processes of improvement through this cooperation in actual physics classroom or laboratory teaching.

Keywords: teacher's profession, teacher education, class observation

P2.G05.03

Strand 9: Teacher Professional Development

Poster Session - 2.05

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Improving Physics Teaching Through Technology

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We want to present ideas on how to help improve the teaching of physics by bringing technology into physics classrooms. We focus in particular on our outreach initiative in supporting a number of school districts with ways to improve high school physics education. This initiative is part of Project IMPACTSEED (IMproving Physics And Chemistry TEaching in SEcondary EDucation), a grant funded by the federal government through the Alabama Commission on Higher Education. This project is designed to achieve a double **AIM:** (a) to make physics and chemistry understandable and fun to learn within a hands-on, inquiry-based setting; (b) to overcome the fear-factor for physics and chemistry among students. During the last 10 years we have been offering this project to numerous physics teachers from Alabama and Georgia. During this time, and using a guided-inquiry, hands-on approach, we have identified a number of ways of bringing technology into physics classrooms. A number of technology projects were developed and assigned to the teachers so as to show their students how physics connects to the technological devices around us; in this way, physics is not presented in a dry, abstract way to the students. This method has proven its effectiveness in heightening the students' interest in physics.

Keywords: Technology in physics classrooms, hands-on activities, technology projects, inquiry-based instruction

P2.G05.04

Strand 9: Teacher Professional Development

Poster Session - 2.05

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Investigating the relation between students' reasoning and the pedagogy in university science content courses for future grade 1-6 teachers

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As part of a study of the science preparation of elementary school teachers, we studied the pedagogy of science content course taken by future teachers of primary school (children ages approximately 6-12) in the United States 1-6. We investigated the relationship between sophistication of students' reasoning on exams and the type of pedagogy in the science courses. We devised written content exam questions. These questions were open ended and required students to apply recently learned concepts in a new context. To evaluate the reasoning in the students' answers, we developed a rubric based on Bloom's taxonomy [1] as revised and expanded by Anderson et al. [2] We visited 20 universities, observed the courses and used the Reformed Teaching Observation Protocol (RTOP) [3] to determine their level of interactivity. We ranked the courses with respect to characteristics that are valued for the inquiry courses. Then, we completed a statistical analysis, logistic regression, for 18 courses with about 900 students. This analysis enabled us to estimate the relationship between traits of reasoning and RTOP score for the classes. We also analyzed conceptual structure of students' responses, based on conceptual classification schemes, [4] and clustered students' responses into six categories. However, the outcome variable with six categories required more complicated regression model, known as multinomial logistic regression, generalized from binary logistic regression. These regression models were used to estimate the relationship between the sophistication of the categories of conceptual structure and RTOP scores. However, the outcome variable with six categories required more complicated regression model, known as multinomial logistic regression, generalized from binary logistic regression. With the large amount of collected data, we found that the likelihood of the higher cognitive processes were in favor of classes with higher measures on inquiry however, the usage of more abstract concepts with higher order conceptual structures were less prevalent in higher RTOP courses.

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Keywords: teacher preparation, reasoning, interactive pedagogy,research

P2.G05.05

Strand 9: Teacher Professional Development

Poster Session - 2.05

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Professional development of teachers in research based co-planning of intervention modules in physics

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A significant and effective teaching/learning path in physics requires didactic laboratories, where hands-on/minds-on activities [1] and RTL [2-4] involve the students in the interpretative challenges of relevant phenomena from the point of view of the physics, its application, daily life [5-6], with gradual assumption of responsibility over their own learning [7-8], through a "conscious" process of analyzing problems, criticize experiments, selection of alternatives, planning investigations, "construction of coherent arguments "[9].
Professional development of teachers is a crucial point, to translate these research results into teaching practice in schools, which can be answered by co-planning activities by teacher-researchers [10-11].
Study and setting up of modalities of co-planning didactic laboratories were research objectives of the project IDIFO3 PLS [12] of Physics, coordinated by M. Michelini, in the activities performed in presence in the bi-annual period 2010/2012 by the Research Unit in Physics Education (URDF), University of Udine [13]. These workshops have been implemented for three phases, often carried out in parallel: co-planning, experimentation, evaluation. They were the context to give answers to the following research questions: RQ1) Role played by research in physics education for co-design of innovative educational paths to be implemented in schools. RQ2) mode of interaction between in service teachers and researchers effective for this purpose. RQ3) Major critical.
The monitoring of the phases of co-planning, educational projects developed by teachers, the documentation of the results were the sources of research data.
The PLS Laboratories for secondary schools involved 15 schools, over 30 classes and 800 students in three Italian regions (Friuli VG and Veneto in the north-east and Calabria in the south) and covered the following topics chosen by teachers: Energy, RTL on Motion and Electrostatic, Advanced physics experiments, Diffraction optics, Electromagnetism, Thermal phenomena with sensors; Superconductivity.
Laboratories PLS for basic schools (kindergarten, primary, middle school) involved 24 schools, 47 classes of Friuli VG, over 800 students concerning: Thermal phenomena; Energy, Sound, Fluids, The measure, Study of motion, Concept of time.
From the monitoring of co-planning laboratories, there are various roles played by PER. Educational proposals based on research and related educational materials (www.fisica.uniud / URDF) have formed: the basis for teachers' choices of topics to be addressed, subject themselves to the study and analysis phases of joint planning, refer to the design of educational path design and experimented by teachers in the classroom. The research on student learning have implications in reflection activities with teachers, in terms of nuclei on which to discuss the typical ways in which the difficulties of the students arise and are recognized, how they are addressed in the scholastic tradition and teaching as well in the research proposals.
The three phases of co-planning have been developed in different ways: 1) an initial meeting to define issues and work program, in some cases supplemented by a general seminar discussion of issues and problems of science and teaching that will be addressed; 2) 3-4 subsequent meetings to define content, experiments, work materials, work program in the classroom, which occurred in the analysis or experiential mode of learning materials based on research and proposals for use with the children themselves, or as laboratory of educational design based on the reorganization of the research based reference materials, or as action research implemented via shared paths of experimentation, the results obtained and problems encountered, ongoing redesign of operations, or design and setting up of new proposals experienced in class and then monitored with research methodologies.
An innovative formative methodology involved university researchers in the development of path with students when the teachers monitored, with subsequent discussion on the lines of development of the educational activity, ways of integration it in curriculum planning, knots of students emerged.
The experiments in the classroom have provided different methods of implementation: autonomous experimentations of the teacher, based on co-design and evaluation conducted by the researchers, co-conduction by teacher and researcher and collaboration in monitoring, feed-back to work with students and directions for the redesign of the intervention; conduction in successive phases by teacher and researcher following a common educational path.
Among the main critical elements emerged, the following are identified by teachers: a) need for broader, deeper and continuous support than the provided by the guidelines of the PLS b) tendency to delegate to its role as a university lecturer teaching c) suspicion of educational innovation, especially in high school has been accepted as qualified on the cultural orientation or d) distrust in the use of ICT in the didactic laboratory, especially in basic education; e) difficulty in analysis and qualitative summary of the results learning of the boys.

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Keywords: Teacher professional development; co-planning; didactic laboratories

P2.G05.06

Strand 9: Teacher Professional Development

Poster Session - 2.05

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Promoting Physics Understanding through the use of Creative and Teacher-Led Continuous Professional Development (CPD)

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This paper offers analysis and evaluation of a unique and immersive approach to science teachers' continuing professional development (CPD) designed and run by National Centre for Excellence in Mathematics and Science Teaching and Learning (NCE-MSTL) and the Kerry Education Service (KES) in Ireland. The three year project began in September 2010 with the aim to develop the investigative skills of junior cycle science students, thus preparing them for their practical assessment they are met with in their third year of junior cycle education. In an attempt to shift the focus from students simply following the 'recipe' when carrying out experiments and passively receiving information from the teacher, this research study aims to provide a framework which will guide, both the teachers and students alike, through the investigative science process. In order to facilitate this the teachers participating in the research received on-going training on teaching approaches suitable for Inquiry Based Learning (IBL) and were then asked to integrate the methods and strategies into their science lessons. In total eight science teachers participated in the research study and five training were provided each year. Topics covered in these training sessions include IBL lesson planning, scientific language, the teacher as a facilitator of learning, reflective practice, and cooperative learning, amongst others.

This research paper reports on one such aspect of the project and looks in detail at the training provided to the teachers to help them teach the topic of Electricity. The pre and post diagnostic tests given to the students are examined and the misconceptions held by the students (before and after instruction) are identified. The students' use of scientific language, both technical and non-technical is also discussed in this paper, thus indicating the level of proficiency of scientific language and use of everyday concepts.

Analysis of the data indicates that the inquiry based approach increased the teachers' attitude towards teaching electricity but also their confidence with regard to facilitating IBL in their classroom. Preliminary analysis of the diagnostic tests suggests that second year students (14/15 year olds) hold many misconceptions relating to electrical charge. Conceptual change was identified in the students' post-tests; however issues still exist in the areas of scientific language. Possible techniques to remedy this are outlined and discussed in this paper.

Keywords: CPD, Inquiry-Based Learning, Electricity, Junior Cycle, Diagnostic Test

P2.G05.07

Strand 9: Teacher Professional Development

Poster Session - 2.05

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

LAPEN Training Physics Teachers Program

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The Latin American Physics Education Network (LAPEN) was created in the World Year Physics (2005) and is constituted by working groups on Physics Education that exist in different countries of the region. LAPEN has the following goals: 1) Promoting the results of Physical Education research and in advance experiences, scientific meetings and other important events in Physics Education, 2) Promoting the exchange with other networks, working groups and scientific societies related with Physical Education, and 3) Contributing to the improvement of Physics Education and the teachers of this subject in different educational levels, mainly in the Latin America area. Recently, in this last point the Institute of Science Education sponsored by LAPEN since 2010 and the National Polytechnic Institute from Mexico City have done a lot of work in order to make new groups of researchers on Physics Education and Science Education. Thus, we present some results related with a training Physics teachers program by means of distance education. The program includes instructors from Argentina, Brazil, Colombia, Cuba, Mexico and Spain participating in a master and PhD on Physics Education using Information and Communication Technologies. The main research line is focussed to active learning of Physics, specially Classical Mechanics, Thermodynamics and Electromagnetism, where we emphasize the use of modern methodologies of Physics teaching such as workshop Physics, interactive lecture demonstrations, peer instruction, Physics on real time and tutorials. These methodologies are very important because their effectiveness has been probed in several developed countries but in Latin America there are only a few researches about. Therefore, different social and cultural aspects should be considered with the use of these novel methodologies. We have students from Brazil, Chile, Colombia, Ecuador, Mexico and US working on college and university levels. We discuss the problems and challenges that we have had to structure this training program based on virtual platforms and the achievements obtained in several master and doctorate thesis in the last five years.

Keywords: Training Physics teachers, academic networks, distance education

P2.G06.02

Satrand 11: Motivational Strategies and Metacognition

Poster Session - 2.06

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Scientific modeling seen as a conceptual field: theoretical approach and preliminary empirical evidences of possible operational invariants on the learning of physics

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Scientific modeling - understood as the process to construct, validate, use and correct scientific models – underlies modern science, but only in recent decades have efforts focused on developing theoretical frameworks and didactical strategies to support modeling activities in physics teaching. Here we present a theoretical approach and some empirical evidences for our thesis that the scientific modeling process can be seen as a conceptual field underlying the domain of specific conceptual fields in physics. We adopted Mario Bunge's epistemological perspective to define a Conceptual Structure of Reference (CSR) for scientific modeling anchored in the concepts of scientific model, referent, idealization, approximation, variable, parameter, domain of validity, degree of accuracy, expansion and generalization. Based on Gérard Vergnaud's theory of Conceptual Fields about learning, and especially in the ideas about conceptions in physics discussed by Weil-Barais and Vergnaud, we argue why scientific modeling can be assumed as a conceptual field, and illustrate it with operational invariants associated to each concept of the CRS. An exploratory case study was designed to gather empirical evidence for our thesis. The case chosen is a young physics teacher, who is also a student in a postgraduate program of physics education. She attended a course focused on computational modeling activities applied to physics teaching, and her experiences in this course constitute the focus of our analysis. We analyzed her conceptions about scientific models, advances and difficulties of conceptualization of the reality and evidences of possible operational invariants on the modeling process. Among the results achieved we found evidence of two operational invariants associated with the construction and validation of scientific models. The first one appeared during the idealization process necessary to model a physical situation. The teacher idealized as much as she was able to imagine, regardless of the theoretical perspective under which the situation was being addressed. The second, in a sense, directs the actions of the teacher regarding the process of validation computational simulations, given that she never considered the possibility that the simulations could be wrong, even when its results were not compatible with those obtained experimentally. These preliminary results encourage us to deepen our analysis towards a framework to develop and implement scientific modeling activities in attempt to foster conceptual understanding of physics contents and coherent conception about science.

Keywords: scientific modeling, conceptual field, operational invariant, computational modeling, physics education

P2.G06.03
Satrand 11: Motivational Strategies and Metacognition
Poster Session - 2.06
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Computational modeling with AVM diagram and its contribution for a meaningful learning of physics concepts and the development of a critical view of science

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A comprehensive training of science teachers involves not only proficiency in their disciplinary field, but also a critical conception of science and its teaching. Although in recent decades there has been a greater emphasis on inclusion of epistemological contents in training courses for science teachers, very often their image of science is far removed from current philosophical conceptions of the nature of science. Reflections on this issue led us to design and implement a teaching proposal, based on the principles of Moreira's Critical Meaningful Learning Theory (CMLT) and key elements of scientific modeling, especially through the use of computational models and the AVM diagram (Adaptation of Gowin's V to Computational Modeling). The main goal was to promote a critical meaningful learning of physics concepts with a better understanding about the production of scientific knowledge. During the application of this proposal, we attempted to answer the following research question: How does the implementation of the principles of CMLT in the classroom - through computational modeling activities with diagram AVM - contribute to the disciplinary, epistemological and didactical training for pre-service physics teachers? A collective case study was designed to answer this question. The case was constituted by seven physics major students attending a course titled "Didactics for physicists" at the University of Antioquia, Colombia. We investigated the progress of these students regarding the nine principles of CMLT during the development of computational activities with the AVM diagram. The most important result was the improvement in the student's ability to formulate good questions in physics class. In general, we found that the integration of scientific modeling elements and principles of CMLT was succeed in improve the student's conceptual domain about Newtonian dynamics. The use of scientific models - as partial and not exclusive representations of the reality - allied to discussions about the scientific modeling process, favored the construction of epistemological views compatible with the currently accepted by the scientific community. In addition, the construction of computational models and the design of learning materials allowed the pre-service teachers to reflect about the challenges to promote a meaningful learning of physics through innovative methods still underrepresented in schools today. These findings lead us to believe that the use of this didactical proposal in pre-service and in-service training courses for physics teacher, could be appropriate to foster a comprehensive training, which necessarily involves addressing disciplinary contents, as well as epistemological and didactical issues.

Keywords: meaningful learning, computational modeling, physics education

P2.G06.05

Satrand 11: Motivational Strategies and Metacognition

Poster Session - 2.06

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Promoting Physics Student Reflection via Reading Logs and Learning Commentaries

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We will describe our use of Reading Logs and Learning Commentaries to promote physics student reflection on their own physics learning in lower division college and university physics courses, and in courses at multiple levels for pre-service physics teachers. Reading Logs are intended to free lecture and classroom time from reading the text, and provide a mechanism to guide, support, recognize and credit students for reading their physics text outside class time. Reading Logs (RLs) are intended to be fast, frequently collected and readily evaluated rewards for appropriate student effort. Learning Commentaries (LCs) are short, three paragraph essays intended to promote reconciliation of student experiences learning physics with their own lived experience through writing. LCs are typically collected only a few times during the semester (typically before exams) and are graded via a sophisticated rubric. We present the forms for RLs and LCs, the LC rubric and some exemplars of student work.
Class time is often wasted going over what students were assigned to read. Reading logs provide students incentive for reading as well as guidance to help them get the most from their reading. The completed log provides the teacher insight into student understanding of the reading. When reading is assigned prior to instruction, reading logs are used to inform the direction of instruction (much like JiTT questions). When reading follows instruction, reading logs can be used to evaluate instruction.
Reading logs are not a new idea in physics. We found a form published by D.K. Apple and have modified the form somewhat based on student input. Reading logs are collected and graded, but we typically use a quick, simple grading scheme, typically based on completion. We encourage students to confine their log to the two page form provided, because some students spend too much time producing the log.
In classes where learning commentaries are assigned, students are typically also asked to keep a journal. The journal is typically checked for completeness, and not graded for content. The following assignment descriptions are taken from a course syllabus:
Personal Journal: Research has shown that reflecting on the day’s learning at the end of class can have a profound impact on learning. You will keep a daily physics diary, writing an entry at the end of each class. You will document your struggles with new ideas; your glories when you “get” an idea, questions about the ideas of others, ideas you develop and want to test, questions for others in the class. These will be occasionally checked for completeness. Roughly a paragraph per day is expected. Each entry should be labeled with the date.
Learning Commentaries: These are three short (3-5 paragraph) formal essays written after and reflecting upon each of the major units that make up this course. A learning commentary is a story describing the evolution of your thoughts on ONE scientific idea. You will describe your initial thoughts, activities, discussions that change or confirm how you think with examples and your final scientific idea. Learning commentaries are word-processed and submitted electronically. Write your learning commentary starting from your journal and binder of activities.
Learning commentaries are graded based upon the quality and quantity of your comments and examples, together with how you support claims for your final scientific idea with specific data taken from classroom observations and activities. In particular, I will be looking for:

➢ a description of your ONE initial scientific idea based upon your previous life experiences, together with a description of your supporting evidence (with your original supporting evidence):
➢ a substantive discussion of how various class discussions and activities promoted change in your idea (with examples and supporting evidence); and
➢ a brief description of your final scientific idea

When we initially used the form from Apple’s book, we found that students had little trouble interpreting the front side of the form. However, students’ responses on the back of the form indicated that students did not understand what was being asked of them. We have modified the form to make process clearer. The use of Learning Commentaries and Reading Logs has helped students’ reading of the textbook and reflection on their learning processes.

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Keywords: reflection, metacognition, reading logs, student writing, learning

P2.G06.06
Satrand 11: Motivational Strategies and Metacognition
Poster Session - 2.06
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

"There's no such thing as a stupid question": what prevents graduate students from speaking up at morning coffee, journal club, and colloquim?

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Many of the science speaking events within astronomy graduate programs - journal clubs, coffee hours, departmental colloquia and thesis defenses - are intended to teach students to speak and think correctly about astronomy research. These events highlight what it means to speak like, and become, an astronomer (Shulman, 2005). They constitute an important yet, strangely, informal (not graded, not heavily guided or mentored) part of the socialization of graduate students into the practice of astronomy. They also represent an arena in which a speaker's intellectual reputation is put at stake (Tracy & Muller, 1994).
Interviews were conducted with PhD students and faculty members in an astronomy department, with a highly-selective, highly-competitive graduate program, in an American Research I university, regarding various departmental speaking events (Baleisis, 2009).
A number of conflicts were uncovered, between official, explicit goals for speaking at these events and implicit and personal goals, which had a strong influence on behavior. The official goals of these events included having a lively, informal discussion among all participants (especially graduate students), and helping graduate students learn and practice their science speaking and reasoning skills. However, both students and faculty interviews implied that these goals were not often achieved.
Even though both faculty and graduate students expressed the desire to promote more active student participation in these events, many students remained quiet during these events. Interviews uncovered significant student anxiety related to speaking about science in front of their peers and mentors in the department. For these students, anxiety about speaking was related to "looking stupid," whether by asking a "stupid question," or not knowing something that everyone else in the room knew. They expressed concern about displaying their knowledge, or having it "out on the table."
These statements are strongly reminiscent of the less desirable side of many influential characterizations of the relationship between student motivation and behavior. For instance:
- Nolen's (1984) ego-orientation (in contrast to task-orientation)
- Ames' (1984) performance orientation (in contrast to mastery orientation), and
- Dweck's (2007) fixed intelligence (in contrast to malleable intelligence) model.
It is surprising to find evidence of such beliefs - e.g., that looking smart is more important than asking for clarification, and that intellectual effort should be hidden - among the graduate students and faculty members at a prestigious academic department. This should cause concern, because these are the same category of beliefs that physics education reformers have worked so hard to change in the reformed physics classroom due to their negative effects on learning.
In this presentation will look at how: (1) the structure of these speaking events, and (2) problematic academic physics and astronomy discourse practices can result in low student participation in these important speaking events and missed opportunities for valuable learning.

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Keywords: graduate education, motivation, science discourse, physics education, culture of physics, astronomy

P2.G06.08

Satrand 11: Motivational Strategies and Metacognition

Poster Session - 2.06

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

First steps into physics in the winery

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Physics is introduced as a basic matter in the curricula of professional schools (i.e. schools for agriculture, electronic, electrical or chemistry experts). These students meet physics in the early years of their training and then continue in vocational subjects where many physics' topics can be useful. Rarely, however, this connection between physics and professional matters is quite explicit. Students often feel physics as boring and useless, i.e. very far from their interests. In this kind of schools it is almost always required the physics lab, but it does not always exist. The physics teachers of a local Agricultural Technical Institute asked us to realize a learning path in laboratory dedicated to their students, since in their school the physics lab was missing. This institute is the only public school in the Chianti area specializing in Viticulture and Enology, and attending a further year post diploma, allows the achievement of the qualification of Enologist. We report the learning path realized starting from thermal equilibrium to a full understanding of the measures made with the Malligand's ebulliometer. This device is used for determining the alcoholic strength (alcohol concentration by volume) of an alcoholic beverage and water/alcohol solutions in general. The aim was to make interesting measures of physical quantities, calorimetry and state transitions connecting them to the functioning of an instrument that students use in their professional career. We present our considerations on the students' learning process and on the possibility of extend a similar path. The feedback of students and the interests of their teachers convinced us to go further in this way. We intend in the coming months to involve teachers of physics and vocational subjects in the design of a physical path spread over two years in which the main physics topics will be introduced to explain the functioning of tools and equipment used, normally, in the winery.

Keywords: Vocational school, motivational strategies, laboratory, calorimetry, change of phase

P2.G07.01

Strand 15: Physics Teaching and Learning in Informal Settings

Poster Session - 2.07

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

A study of parental involvement in their children's physics learning in Taiwan

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Recent years, some researchers have noted the importance of parental participation in their children's learning. If parents provide support, care about children's school life, and help out with homework, for example, improved test results and overall performance often result. The authors believe that science education ought to begin at home, reinforcing parents' knowledge as well as helping the children to learn. To date, however, relatively little work has been done on this topic in Taiwan. A three-year project was set up to emphasize this point. In the first year, the study was to explore parents'view about parental involvement in their children's education. In the second year, the study was set up parental physics learning groups and evaluated the effectiveness. In the third year, the study was concerned about the influence by using take-home inquiry science activities. The results revealed parental learning groups and take-home science homework could improve parents' attitudes toward physics activities and interact with their children. Moreover, it is worth to enhance parents attitudes to involvement in their children's' education,and carry out take-home physics activities. Parents could have more opportunity for a number of interactions with their children at home. While this study has its limitations, it is hoped that it can serve as a basis for further study in engaging parents involving in their child's physics learning.

Keywords: parental involvement, informal education

P2.G07.02

Strand 15: Physics Teaching and Learning in Informal Settings

Poster Session - 2.07

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Implementing STEAM Instruction for talented/gifted student on light

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Korea national university of education

Implementing STEAM Instruction for talented/gifted student on light

How can we bring the excitement of light physics to the class for the scientifically gifted? The main purpose of this study is to outline developing of physics instruction on seventh grade gifted learners, specifically the students of the class for scientifically gifted in Korea. For learning straight propagation of light, to verify their efficiency, and to acquire implications. In this study, we developed and implemented STEAM instruction for scientifically gifted. STEAM's departments are STEM's departments with the addition of fine and liberal art. For 2011 summer, Seoul Metropolitan Office of Education's the class for scientifically gifted in Korea has offered a physics course for 20 gifted students in the grade seven. Students learn everything from the discovery of light in art pictures to a camera's principle, and engage in hands-on activities such as making shadow, drawing picture of using mirror and simulating a camera lucida and technology of pinhole camera & display, engineering of architecture & lighting and mathematics of sundial. After this class, the students had more scientific conceptual changes than the ones in the traditional instruction. For the STEAM instruction group, the students showed higher motivation and achievement than the ones in the traditional instruction. STEAM is suitable for integrated education to scientifically gifted students. Because STEAM can feel growing upon students an interest in science and can help students to understand science in depth. STEAM also can help sduents to do Creative & Critical Thinking & Problem Solving Skills
This research will outline a unique physics instruction in gifted education.

Keywords: STEAM talented/gifted student light

P2.G07.03

Strand 15: Physics Teaching and Learning in Informal Settings

Poster Session - 2.07

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

An empirical study on a learning path on wave physics focused on energy

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We describe an extracurricular learning path on waves and oscillations focused on energy tranfer. In particular, the advantages of introducing mechanical waves by using the Shive wave machine and many laboratory activities are presented. Laboratories are realized by inquiry, i.e. students explore waves behaviour in qualitative way, guess what can happen and suddenly test their hypothesis. Recently, we presented some disciplinary knots that arise usually in empirical investigation, according to the Model of Educational Reconstruction and discussed methodological choices made in designing the learning path and preliminary result about its realisation with few, interested and talented pupils. Despite excellent boundary conditions, some learning difficulties arose. We report the second year of this learning path performed with the same students. The students are introduced to more complex topics such as analogy in waves phenomena and resonance.

Laboratories are described with particular attention for the energy transformation. We planned activities by focusing on conceptual issues such as characterization of the oscillatory motion and energy aspects vs. characterization of wave energy and energy transport. We designed the activities in order to propose a complementary experience compared to what was done in class. Despite resonance is a relevant phenomenon which runs through almost every branch of physics, many students have never studied it. Yet, resonance is one of the most striking and unexpected phenomenon in all physics and it easy to observe but difficult to understand. Students performed many activities in laboratory on several resonant systems. Our purpose was to outline how it is possible to tune a system or a device in order to obtain resonance and an efficient energy transfer from different physical systems, such as a mechanical one and an electrical one for example. This year, the final task of this learning path was to analyse different natural phenomena in order of choosing the most suitable for energy transfer. Finally, we present our considerations on the students' learning process and on the possibility of extend a similar path in a classroom.

Keywords: wave phenomena, resonance, energy tranfer, analogy

P2.G07.04
Strand 15: Physics Teaching and Learning in Informal Settings
Poster Session - 2.07
Date & Time: 05.07.2012 / 13:00 - 14:00
Room: D406 (3rd Floor)

Ten reasons to give credence to anthropogenic climate change

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Any course of action has costs and benefits. To obtain the benefit, we need to pay the cost. No power plant pollution means no power plants. No power plants means no electricity. No electricity means no modern surgical procedures, no medical diagnostics, no comfortably lighted and cooled homes, etc., all things most people want to have or at least have available to them. One consequence of human use of energy is emission of greenhouse gases. Many nonscientists (as well as a few real scientists) do not think that climate change could be caused by human actions. Reasons range from doubt that tiny humans could affect an entire planet to belief that human life on Earth will soon end. Science is about experimental data, reasoning from those data, and theoretical perspectives supported by the data. Svante Arrhenius provided (in 1896) the first theoretical (and compelling) reasons that carbon dioxide could influence Earth's energy budget. Multiple sources of modern data underlie the belief of virtually all climate scientists that humans are changing the climate. The evidence is based on temperature measurements, satellite observations, ice-core sampling, statistical analyses, sea level measurements, observations of plant and animal behavior, and other sorts of measurements. The nature of science is something that should be shared with students and fellow citizens, and an important feature of science is its reliance on evidence. We provide ten evidentiary reasons to accept that humans cause climate change. They are (1) Earth is not at 255 K; (2) Earth's stratosphere is cooling while the troposphere is warming; (3) Satellite measurements show that less radiation escapes to space than before; (4) Non-peer-reviewed claims that weather stations' location caused the "apparent" warming in average temperature have been withdrawn by the person who originally made them, in peer-reviewed literature; (5) Earth's temperature is rising, particularly since 1980; (6) Most continental glaciers are receding and Arctic sea ice is declining; (7) Sea level is rising, and the oceans' pH is changing; (8) Species of animals and plants are moving toward the poles; (9) Nights are warming faster than days; and, (10) There is little dissent about the existence of the "human fingerprint" among knowledgeable climate scientists.

Keywords: climate change, nature of science, evidence

P2.G07.05

Strand 15: Physics Teaching and Learning in Informal Settings

Poster Session - 2.07

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Light as a substance

Corrado Enrico Agnes

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I propose the use of the "substance model" for the physical system light, and I'll show this is a simple and effective model for the most controversial physical system.
The model of light as a substance is already in use, even tough not officially recognized. The common language is "ready" to use this model as you can see from the following examples, where the light is considered a kind of stuff: the room filled up with light – filtering light – to absorb the light – to analyze the light – the synthesis of white light from different colours – pure light and composite light –...
Recovering what is worth teaching in the old theories about the "simplest substances", and keeping an eye wide open to the modern quantum theories of electrodynamics and thermodynamics, we get a representation of light which is both intuitive and narrative, and substantially correct from the point of view of physics. To support this and show that the substance model completes the traditional description with rays, waves, and particles, I appointed a graphic artist to execute 12 pictures representing experiments with light, some more "gedanken" and unrealistic than others: an attempt to popularize physics with illustrations in the "comics" style and statements in the "slogan" style. I plan to support the posters exhibition with hands – on experiments.
But my major hope is to demonstrate the possibility to build a substantial understanding of an important theme from natural sciences through narrative understanding, with no unnecessary simplification and no dumbing down.

Keywords: Light teaching and learning, Models, Popularization of Physics

P2.G07.06

Strand 15: Physics Teaching and Learning in Informal Settings

Poster Session - 2.07

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

The role of experiment in the learning physics process

Alicja Wojtyna Jodko
The (Polish) Association of Teachers of Natural Sciences and Technology

Not enough pupils/students at the secondary level find learning physics interesting enough to get involved. There are at least two main categories of reasons for that situation:

1. youngsters do not recognize in their surrounding world any interesting phenomena described by physics,
2. youngsters lose their natural ability to observe, describe and investigate, using scientific reasoning and methods has never developed.

For those pupils whose intellectual activity is blocked by emotional disturbances manipulating with experimental sets decreases the level of their inability to learn.
For those pupils who find learning physics boring and not related with the surrounding world appropriate chosen experiments may cause a change in their attitude.

For the last four school years SNPPiT in co-operation with the Institute of Physics (IoP) of the Kazimierz Wielki University (UKW) in Bydgoszcz (Poland) organizes a Physics Experiments Competition, where students (in groups of two or three persons) at primary (2008/2009) and then at secondary levels create their own experimental sets and present their experiments in front of a jury. After evaluating the first edition of that competition we decided to create a Seminar for Young Experimenters. Participants of the Physics Experiment Competition may attend a seminar at the IoP UKW once a month (6 sessions during an academic year) for increasing their interest in physics and developing their experimental skills. Next year they present more sophisticated experiments during the competition.

We have just applied for the EU funds within a project on: "EXPERYMENT: increase of interest of pupils at lower and higher secondary levels for learning physics by such forms of non-formal education as after school interdisciplinary activities, Seminar for Young Experimenters, EXPERYMENTARIUM and educational paths" to create an EXPERYMENTARIUM – a kind of a science museum, where experimental sets created by pupils, IoP students and young employees will be exposed. Also two local educational paths will be created: one of them will present scientific description of a place where a local school for training glider pilots existed for 33 years, the other one will present our Solar System in the appropriate scale. This will be realized in co-operation with the Institute of Astrophysics of the University of Liège in Belgium.
We are going to keep the experimental sets created by pupils for the Physics Experiments Competition, make them more stable to become appropriate for a long time use.
Both theoretical considerations of the reasons as well as empirical experiences in our co-operation within out-of-school ways of organizing space for learning physics will be presented.

Keywords: experiment, physics education, out-of-school activities, experymentarium

Close cooperation of Primary, Secondary and University professors to teach distance forces concept in primary school

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Educational programs in Primary School in Uruguay have changed steeply since 2008, mainly by adding new contents in Science. Given that primary school teachers have not an extensive training in Science (especially in Physics), they do not feel sure when working in the classroom with scientific concepts and experiments. Usually, when they attempt to make an experiment, they follow a very passive methodology, showing it to the children as a recipe, that could leads them to a naïf credulous attitude towards Science and Technology (Reyes, 1972).
Therefore, implementing a new Science program in the classrooms is a challenge for the educational system, that requires a coordinated work between its different actors, from Primary School to University. For this reason, the Administration of Public Education (ANEP) and the Program for the Development of Basic Sciences (PEDECIBA) have created a national-wide program for improve the quality of the science education in public schools of Uruguay ("Programa de estímulo a la cultura científica y tecnológica").
Within this framework, "Eppur si muove: Distance forces in the Classroom" was a one of the selected projects in 2011. It was carried out by a team of teachers from Primary School, Highschool and University with the goal of collaborate with Primary School teachers in three areas of Physics covered by school's program: Gravitation, Magnetism and Electricity. The project team designed several experimental activities for making in the classroom with kids ranging from 6 to 12 years old, through a methodology based on the construction of the physical concepts by the own children. Indeed, kids had to get familiar with key scientific methodology, such as formulate questions, define variables, classify data, test hypothesis, etc. All activities were based on low cost materials and specifically designed for being made by the teachers without further assistance. Some theoretical materials, related to the activities, were chosen for supporting teachers in the task of teaching Physics. The final outcome of the project was to make available all the material for being used and customised for another teachers in the future.
The project was carried out along three months, working with 286 children and 10 primary school teachers, from first to sixth grade in 2 public schools near Montevideo. General guides for all the activities were prepared by project crew, each one corresponding to a topic:
Introduction to forces: Several materials were distributed to groups of children, encouraging them to move polystyrene balls without touching them. Then, all groups share their findings in plenary classifying each way to "move" the ball in a kind of force.
Gravitation: After revising previous ideas about gravitation and free fall, they are encouraged to make their own experiments. They are driven to make an ordered set of experiments, defining variables and setup conditions. Results are discussed along a history line of major milestones in the theory of gravitation (Aristotle, Galileo), in order to understand how scientific ideas evolve (Dibarboure, 2008).
Magnetism: Students classify different materials as magnetic or not, discovering, for example, that not all metals can be attracted by a magnet. They analyze the interaction between magnets.
Electricity: Simple experiments of static electricity are done for introducing basic concept, such as electric charge and polarization. After that, they manage to construct simple circuits, in order to learn basic concepts, such as electric current and polarity. They use a conductive dough for design malleable circuits, changing its dimensions to learn that resistance depends on geometrical features.
After presenting the whole set of activities to each primary school teacher, the workshops were planning together between them and project team, adapting contents and activities. Some of them felt enough confidence to carry out the workshops almost without assistance, while another have to be supported along the whole workshops.
At the end of the project, primary school teachers evaluated it very positively, underlining that proposed activities permitted children to take an attracting and motivating approach to Physics' concepts, giving them, the opportunity both to experiment and to reflect about theoretical concepts. Guides have a Creative Commons licence and are available to download from project's blog. They have been taken by the national-wide program as one of the resources for being spread to the educative community.

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Keywords: primary school, educational programs' improvement, physics concepts

P2.G08.03

Strand 5: Primary School Physics

Poster Session - 2.08

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Don't be afraid of Physics – Interactive activities from Physics for basic-school pupils

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The poster presents the goals and the first results of a project whose aim is to give basic-school pupils an opportunity to carry out their own discoveries via active learning and to independently find reasons and explanations for the phenomena observed. Through individual activities for pupils oriented on active learning, i.e. learning via discovering, learning from experience and creation of their own projects we want to develop their motivation, science literacy and a positive attitude towards a future scientific career.

Pedagogical research has shown that one of suitable innovative learning methods is inquiry-based learning because it increases students' conceptual understanding as well as develops their understanding of scientific inquiry and the nature of science [1, 2]. Since the attitude of pupils towards science is formed already during their early school years we have decided to propose a project which aims to help basic-school pupils discover the essence and beauty of the scientific research via interactive activities. The project was supported by the Slovak research and development agency and is being carried out since September 2009. Besides activities for pupils, the project also includes workshops for teachers aimed at preparing them for realization of the interactive activities and thus achieving implementation of the activities by as many schools as possible. Through presentation of the work results of pupils participating in the project we present physics to the general public as an interesting science that we encounter in our everyday lives.

Summary of the up-to-now project

RESULTS:

- Methodical materials for realization of 12 different interactive activities targeted at active learning were created so far in the form of worksheets for pupils and instruction lists for teachers.
- The activities for pupils were presented in workshops and seminars to more than 100 basic-school teachers. At these events the teachers were also able to try out these activities themselves.
- More than 300 basic-school pupils have participated in the project activities so far.
- We have organized two student scientific conferences where the pupils had an opportunity to present the results of their explorations.

Some examples of the activities: In the activity named Can we weigh the air? the pupils with a help of simple tools – such as a bicycle pump, a graduated cylinder, a water tank, a ball and an electronic balance – based on a graphical representation of the measurement results experimentally determine the density of air.

In the activity named The black box secret the pupils are made familiar with the method of a black box, which is one of the basic methods of inquiry. The pupils are given the opportunity to form hypotheses and to verify them by means of an experiment. This allows the pupils to successfully reveal the contents of the black boxes without opening them. At the same time they are able to test and strengthen their knowledge about electric circuits this way. The activity named How do we breathe? (or breathing from the point of view of physics and biology) offers the pupils a set of computer-aided experiments oriented at human breathing: the pupils first create a model of lungs with a help of simple tools, then they model human breathing and, finally, with a help of a computer-aided experiment they measure the pressure during breathing, what is their breathing frequency at rest and after some physical activity, etc. These activities make physics closer to problems of the everyday life and prove that physics can be found everywhere around us.

CONCLUSIONS:

From the formulation of the individual activities follows their dedication to the development of the key competences of pupils. The activities develop the ability of pupils to solve problems in a creative and critical way, the pupils gain skills with usage of modern technologies, the work in teams during the execution of the activities develops their personal and interpersonal skills and expands the communication skills and competences of the pupils. Since in the world methods dedicated to active learning are being developed more and more, we would like to confront our findings and experiences from the realization of our project with the experiences of others and thus continue to improve our work.

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Keywords: active learning, interactive activities, basic school pupils

P2.G08.04

Strand 5: Primary School Physics

Poster Session - 2.08

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Wow, it works! Introducing electricity to children

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Who does not know the kids' toys that start to work at the moment when one simultaneously touches the two contacts? Connecting the two contacts through human body, toys usually start to emit light and/or sound. But, how does it work, what is inside the toy? An investigation reveals that the electronic circuit is rather complicated to unravel.

In this contribution we present an electronic circuit that has similar effects as the complicated circuits in the toys. An accompanying teaching sequence where primary school children (age 10-14) investigate and deal with the above problem is presented as well. The objectives of the teaching sequence lay a great stress on students' active learning, where they develop motoric skills, identify the electronic elements, getting to know the electric circuits with its basic components and connect their knowledge with a daily life.

The proposed electronic circuit is made on a small wooden plate on which the electronic elements and wires are fixed by nails. The sketch of an electronic circuit is applied directly on the wooden plate, with marked points for nails, contacts and elements. Nails are suitable for contacts and they also protect the electronic elements from mechanical damages. The device is made of easy accessible materials which allows for a robust and consequently long lasting device. It includes LED that emits light when one touches the contacts. If students hold their hands and contacts are connected through the "human chain" students can realize that a human body is electric conductor. With the device the electric conductors can be distinguished from electric insulators.

Strong points of the teaching sequence are in students' awareness that they are able to make device on their own, and that the device actually works. The knowledge they gain through experimental work and testing the device is applicable and helps to understand the modern technology devices. Furthermore the device is based on the light emission which enables that the device indicates current when the contacts are connected and cases to emit light when they are not. The proposed device is in contrast to the toys which play sound whenever someone touches the contacts. The problem of understanding of current occurs since the toy stops to play even if the contacts are still connected.

However the electronic circuit can be used in lower classes of primary school as well, if it is used as a detector of electric properties of materials. Since the performance of the device is in this case left to the teachers, we presented the topic in a national workshop for teachers. The responses on the workshop were promising and motivative for further activities.

Keywords: electricity, electronic circuit, electric conductiors, electric toys, teaching sequence, active learning

P2.G08.06

Strand 5: Primary School Physics

Poster Session - 2.08

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Web-based Resource to Support Responsive Teaching and Scientific Inquiry in Elementary School

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We see scientific inquiry as the pursuit of coherent, mechanistic accounts of natural phenomena—coherent in the sense that ideas fit together, and mechanistic in the sense of cause and effect [1]. As part of a project [2] aimed at thinking about learning progressions in scientific inquiry we have been working with a group of elementary teachers to help them engage their students in this pursuit through a strategy of responsive teaching. In responsive teaching, teachers' pay attention to the substance of students' ideas and reasoning and make next move decisions based on those ideas. To help teachers progress in their ability to teach responsively, we have been developing a web-based resource, a 'curriculum.' [3] There are many challenges in developing a 'responsive curriculum.' First, because decisions about what happens next in the classroom are based on the students' ideas that emerge, there is no prescribed order of doing activities or discussing topics. Unlike other curricula, which provide an ordered sequence of topics to cover and activities to do, a responsive curriculum cannot provide such an ordered sequence in advance. Second, our own experience has shown that curriculum and professional development are significantly intertwined. As teachers practice responsive teaching, that is, as they 'enact' their own curriculum, they need continued opportunities to think about student ideas and next moves. Third, teachers are expected to 'cover' certain content standards, and this sets up a challenge for teachers to coordinate both content and inquiry objectives, especially, in the spirit of responsive teaching, if the teacher chooses to follow up on students' ideas that don't match the content standards. This latter issue is particularly important because the new science education standards being developed in the United States is going to deeply integrate both practice and content. [4] The purpose of this poster is to describe some of the important features and affordances of our prototype web-based resource to address these challenges.

Instead of focusing on a prescribed curriculum surrounding our project modules, in our resource we provide rich examples of the 'enacted' curriculum; that is, what teachers actually did. We represent these enacted curricula in the form of nodal diagrams, where each node represents a significant issue that emerged in the classroom, but where multiple possible pathways are shown emerging from each node representing other choices the teacher could have made. When viewers click on each node, they are provided with various classroom video clips and are guided to engage in substantive discussions about students' ideas and reasoning and next moves. The teachers who were videotaped then provide audio commentary where they reflect on what they saw in the students' ideas and reasoning and their own rationale for next moves. In the poster we will also provide an example involving the topic of energy of how a teacher coordinates inquiry and content objectives in responsive teaching. [5] We see this web-based resource as being useful not only to teachers needing support to teach responsively, but also to science educators and researchers who want substantive examples of what responsive teaching in science and a responsive curriculum might look like.

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Keywords: Responsive Teaching, Curriculum, Scientific Inquiry, Elementary Science Teaching, Professional Development

P2.G08.07

Strand 5: Primary School Physics

Poster Session - 2.08

Date & Time: 05.07.2012 / 13:00 - 14:00

Room: D406 (3rd Floor)

Using action research to improve teaching of electricity for primary science physics

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Physics in the school primary curriculum in Malaysia is integrated into the Science subject. Thus trainee teachers in the Teachers Training Institute in Malaysia are trained to become primary science teachers where physics courses are part of the curriculum and taught with the other science fields. As the training of the science teachers emphasises on the Science teachings as a whole, not much emphasis have been given to the teachers' delivery of the physics concepts. Thus trainee teachers often faced problems to plan and deliver the physics concepts, prepare and use suitable teaching materials and approaches to teach physics in their primary physics classes during practicum. One concept that has always contributed problems to most trainee teachers is electricity.

A trainee teacher realised that he was not able to conduct an experimental class for electricity smoothly due to several problems. When he reflected on the problems, he realised that the main contributor to his problem was that he was unable to prepare appropriate materials for his experimental classes. He also realised that his Year 5 pupils do not recognise electrical components symbols and were unable to prepare basic circuits from the circuit diagrams given in the science textbook. The pupils were unable to visualise current flow in a simple circuit, series circuit and parallel circuit.

Based on his reflections of the problems, he developed an action plan which was to; use symbol model to constantly refresh his pupils on the electric components symbols, prepare an electric kit, the Simple Circuit Kit for pupils to conduct experiment on circuits, and use analogy to discuss current flow in a series and parallel circuit. These actions were designed to improve on his ability to manage experimental class for the concept electricity and were implemented during his internship at a school in Kuala Lumpur.

The findings of this action research proved that the trainee teacher has improved on his ability to conduct an experimental class in electricity. Observations on the pupils conducting the experiment indicated that the pupils were able to connect the circuits and gained the necessary skills needed for experimenting. Pupils gained results from the experiments, thus making them more interested in the lesson, able to provide conclusions and answer questions related to the experiment. The pupils also responded in a questionnaire that they were able to conduct the experiment easily and quickly with the help of the Simple Circuit Kit. A test administered before and after conducting the action plan shows that pupils' understanding of the electric concepts have improved and they were able to answer most of the questions given. This is because they have obtained the appropriate results from the experiment and able to make their own conclusions from the experiment conducted.

The outcome of this research shows that teachers could improve their teachings of the physics concepts by reflecting on their problems, plan and take actions to overcome the problem. These actions could lead to innovative measures to prepare materials that could help teachers overcome problems related to their teachings.

Keywords: action research, primary school physics, students teachers, electric kit

Less Teacher Talk, More Student Talk - Dialogic Inquiry on Newton's Second Law

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Background, Framework, and Purpose
Is it possible to make teachers believe that less teacher talk will improve learning out-comes after teaching physics at upper secondary school? Teachers were challenged by physics education researchers to compare two different instructional designs to teach Newton's second law by using the same class divided in two similar groups, and the same teacher teaching both groups. The teachers decided themselves to work with Newton's second law, a physics concept that gives students in upper secondary school difficulties, as it is contra intuitive and shows a big step from everyday thinking to the scientific view. Leach and Scott (2002) characterized such a concept to give students a big learning demand.
The framework for the study is grounded in the idea of dialogic inquiry (Wells, 1999). The classroom talk is linked to the quality of the learning that takes place and gives capacity for students to think and discuss, not only to remember. Teachers' questions are vital for opening the dialogue in a certain direction. Mortimer and Scott (2003) describe classroom dialogue in two dimensions interactive/non-interactive and authoritative/dialogic, and by the expression turning-point, they give opportunity to point at the moment when the class are crossing from an everyday view into the scientific view of a phenomena. In ordinary classroom teaching, the teacher has ownership to the multimodal representations that will be used to present the physics topics. Is it possible to move the use of semiotic resources (i.e.mathematics, pictures, graphs, gestures etc. See for example Kress et al., 2001; Airey & Linder, 200x) towards the students as active users instead of the teacher?
The physics laboratory work during the lessons will be discussed from an educational reconstruction approach (Viiri & Savinainen, 2008; Koponen & Mäntylä, 2006), but also from a more individual learning demand approach (Leach & Scott, 2002). We see physics laboratory work as purposeful for learning, a good starting point for students' own construction of knowledge, and a natural part of a content specific approach to physics teaching.
Purpose of the study was to establish a research "affinity space" (Gee, 2007) for creative ideas to elaborate physics teaching based on physics education research, and to find answers to the following research questions:
- How do teacher change their instructional design and approach when they are challenged to elaborate specific the variables of 1) distribution of talk between teacher and students, and 2) the contextualization of examples given during lessons?
- Describe and discuss the mechanisms when teachers increased awareness of the importance of more student talk change the representations afforded to students.

Setting
A class was invited to the university and one of the school teachers volunteered to teach two halves of the class (22 student) with different instructional approaches. The two lessons were performed the same day, both 3 hours long including a 30 minutes break. The first lesson aimed to involve students more directly with an authoritative but interactive style, which was the teacher's ordinary approach, and the second to be more inviting towards a dialogic interactive approach, by giving small groups questions to discuss and then discuss together with the teacher in front of class. Both lessons used a sequence of short experimental demonstrations, to proceed towards better understanding of Newton's second law. The second lesson also used a more contextualised approach to present physics ideas, to invite to more dialogue.

Results, Conclusions and Implications
The teachers' interpretation of dialogic inquiry gave an instructional design, driven by contextualised physics situations to be discussed in small groups. These discussions were reflected on in class after one group representative first had reported the results from the group discussions. To let a representative report the group discussions was the teachers own idea and was very fruitful. The design resulted in more student talk and less teacher talk compared to the first "ordinary lesson", measured from the transcribed video-recordings. The representations used were also more distributed between teachers and students in the second lesson, as the students did more of the experiments on their own.
Student evaluations judged the first lesson alternative as "good but ordinary teaching – fun with all experiment and demos", and the second as "very good and interesting with the small group discussions, and be able to follow if the own ideas gave strong enough argument in the class discussions".
The study found tendencies that how the teachers use a variation of communicative approaches in a lesson have impact on both the learning outcomes and on student interest. The study increased the teachers' awareness of how their questions to the students change the learning environment for the students. The Force Concept Inventory given to the class as a delayed test showed better gains for the students taking part of the lesson with the more student active approach.

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Keywords: physics education, communicative approaches, representations, multimodality, Newtons second law

PS.10.01.b

Strand 2: Teaching Physics Concepts

Parallel Session 10.01

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D402 (3rd Floor)

Expanding students' schemas about motion by using photographs

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Admittedly, improvement in science instruction is needed. Mechanics is perhaps the most extreme example of the failure of science teaching at high school. Schema theory provides a good framing for analyzing students' knowledge in motion, and we used it in our previous work in which we determined students' schema about concepts in kinematics. We noticed, as shown by many other studies, that students have difficulty differentiating the concepts of position, velocity, and acceleration as well as the concepts of time and position interval. These problems lead to two important misconceptions, namely "the same position means the same speed" and "leading/following particle moves at a faster/slower speed". Just because there are many misconceptions and p-prims in students' schema does not mean their schema lacks the related knowledge.

Data show that students often possess weak patterns of association, which they apply to physics task. This weak association often implies fragmented sets of knowledge containing pieces of information that are inconsistent with one another. A strong pattern of association is characterized by pieces of knowledge that are frequently elicited together in a wide variety of situations. We refer to robust patterns of association as schemas. A schema is a set of coherent knowledge that gets brought up in a set of similar contexts or situations. Schemas contain facts, rules, p-prims and other spontaneous responses that are used to accomplish a certain goal. Although schemas are not necessarily correct, the relations among the pieces of knowledge are important for us to identify if we are to understand how students reason.

If we create different situations for students to learn kinematics, their schemas' associations increase to help them solve more problems. Therefore, a two-week photographs-based high school course was designed and taught with the intention of promoting students' conceptual understanding of motion. We believe photos can provides us with both a fixed time and position and the opportunity to examine the fixed situation.

Visual literacy is defined as the ability to explain, understand, and learn through figures and pictures. Using pictures is often a more wide-spread and comprehensible language than verbal language. Visual literacy in education enables instructors to enjoy more communicational ways in their interactions with students. In educational pictures, students should learn to alter their perception of pictures from regular to an educational one, so they can better comprehend what they see. Pictures/figures/image should help students to substitute misconceptions with the right conceptions. Pictures/figures/image gives a feeling of reality to learners through which students can gain experiences otherwise difficult to learn about in details e.g. phenomena with a very slow motion or growth, phenomena with an extremely high speed. Studies done on education and educational Pictures/figures/image indicate positive and lasting effects of this type of education.

The same results were found in our survey. Our research question was whether using photos helps students to overcome their misconceptions about motion. The answer is yes, having investigated the learning extent of 25 students who were taught with photos and comparing it with the experimental group who were instructed through regular methods. Our photographer was expert in both taking photos and teaching physics. Five photos are used for instruction and interpretation of real situations. In the first step, students were told to interpret photos based on their own emotions. Then, the teacher helped them to notice other information remained unnoticed by the students. And finally, they were asked to associate photos to other situations. Only one of the photos is presented in this abstract and others are provided in the full essay.

A questionnaire with conceptual questions was used, in which different contexts were employed to assess coherence of students' schemas about motion. Both groups of students answered these questions before and after the instruction. Comparison of the results shows that using photos provides students with opportunity to broaden their views about motion. Kinematics is one of the pillars of mechanics, which has a strong relation with our physical environment. In spite of that, students have problems with it in both classroom and real life. The current survey shows photos can help students to make sense of this important part. It provides a language for concise expression of physical laws. In sum, we should take as much advantage as we can from this short cut in our instruction.

Keywords: photograph, kinematic, teaching

PS.10.01.c

Strand 3: Learning Physics Concepts

Parallel Session 10.01
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D402 (3rd Floor)

An Investigation of Correlations between Concepts in Newtonian Physics and Conceptual Diagrams in FCI

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The Force Concept Inventory (FCI) is used to assess student understanding of the most basic concepts in Newtonian physics. The FCI is constituted by the multiple-choice questions. A respondent chooses from the choice one item it is considered that is right. Therefore, a possibility that there is no correlation in choosing the correct item and understanding the concept is also considered. Additionally, some questions of FCI use conceptual diagrams. In the case of the question using such conceptual diagrams, the information that the respondent has acquired from the diagrams may differ from the intention of the question. The conceptual diagram here means the abstract figure explaining the situation of the question. A realistic picture is excluded from the conceptual diagram.
An investigation about how conceptual diagrams in the FCI are understood by student was carried out. The investigation was conducted using a question form that was made based on FCI. Each items of the question form were extracted from the FCI using a conceptual diagram and were reconstructed as a question that is not a multiple-choice question. The question form was made into the description type. The subjects of investigation were undergraduates of my class. This class was for students of science and engineering that were not physics major. The pre-test of FCI was carried out at the beginning of the term, and the post-test of FCI was carried out in the end of the term, respectively. The investigation was conducted after the post-test of FCI.
According to the results of the investigation, it was suggested that the correlation of choosing the correct answer in the diagram and understanding the corresponding concept is low in the low-scorer of FCI. It seems that they picked out the correct answer by the interpretation of the diagram without the basic concepts in Newtonian physics.

Keywords: conceptual diagram, FCI, undergraduates

PS.10.01.d

Strand 6: Secondary School Physics

Parallel Session 10.01

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D402 (3rd Floor)

The effects of teaching electro-magnetic induction by inquiry methods on students' process skills and learning

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In this study we tried to investigate the effects of the teaching electro -magnetic induction by inquiry methods on the students' process skills and achievement. Our samples included 19 male students of Haidari School of Hashtrood Town. This group was our experimental group. In the same school but by different teacher, the same subjects were taught to 21 students which made the control group. A pre test-post test design was used as the research method and an observational check list was added in order to survey the attainment of process skills. Besides the student physics final scores and Kanoon Test Scores were utilized as further indication of their achievements.

The findings of this research are: (1) For the first process skill, observation, no significant difference was observed between the experimental and the control group.

(2) No significant difference was observe3d between the experimental and control group in the attainment of the second process-skill, i,e. using measurement tools.

(3) The differences between the experimental and the control group in the 3rd and 4th process skills, i. e., predicting and making inferences were significant.

(4) The student achievement was significantly better in experimental group than the control group.

And (5) The experimental group could design and execute simple physics experiments than the control group.

Keywords: Inquiry teaching, electro-magnetic concepts, process skills, secondary school, academic achievement

PS.10.02.a

Strand 3: Learning Physics Concepts

Parallel Session 10.02
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D403 (3rd Floor)

What do students recall from the inquiry-based teaching?

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From our experience in teaching Physics, we realize that it is very difficult for most of the students to recall what has supposedly been learned. This fact may be related to the way Physics is traditionally taught and the objectives of teaching, since "transmitting information from the teacher’s head to the student's notebook is an inappropriate goal of education (FINKEL, 2008, p. 35). ”
We believe that learning is building knowledge and that each person internally reconstructs the knowledge collectively built. In school we understand that such a construction occurs through social interaction among students and between the teacher and them (VIGOTSKI, 2007). One approach that has been mentioned in research as a science learning facilitator is the inquiry-based teaching, which emphasizes teamwork and discursive interactions (CAPPECHI and CARVALHO, 2006; LOCATELLI and CARVALHO, 2007).
The aim of this study is to identify what types of elements are recalled by students from one year to another when, in the first year, classes were planned according to inquiry-based teaching. A first factor to consider is memory, which "clearly reveals the social origin of signs and their crucial role in the individual development (VIGOTSKI, 2007, p. 31).” Moreover, people are “the product of the development of physical and mental processes, cognitive and affective, internal (previous history of the individual) and external (social situations) (SILVA, 2008, p. 136).” Therefore, we investigated not only the knowledge built and skills and competences developed, but also the affective and metacognitive (FLAVELL, 1976) dimensions of learning.
For this purpose, we carried out a set of inquiry-based activities in a Brazilian High School class in 2010. For data collection, we conducted, in early 2011, an activity consisting of students’ awareness of topics studied in the previous year; discussion in small groups and collective writing, within the groups, of the knowledge and situations recalled.
Having analyzed the written data in light of our theoretical framework, we established five categories: affective memory, scientific memory, experimentation, classroom practices and metacognition. The affective memory is what the students remember from the lessons, but has no close relationship with knowledge, skills and competences related to the subject. The scientific memory refers to memories of the procedures performed during the activities and are more directly related to the specific knowledge. The experimentation includes the experiments carried out. Classroom practices are other activities, besides the experimentation, which also characterize Physics class. Metacognition refers to the reflection on one's knowledge and the recognition of potentialities and difficulties during learning.
The presence of affective and metacognitive dimensions in the data shows that they should be considered in the process of teaching and learning. The scientific memory seems to be a first evidence of learning Physics, and our next study will focus on assessing if it really expresses what has been learned.

Keywords: learning, Physics, memory, affectivity, metacognition

PS.10.02.b

Strand 17: Various Topics in Physics Education

Parallel Session 10.02

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D403 (3rd Floor)

The Nature Of Thought Experiments Used By Students In Different Levels During Problem Solving In Physics

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In the history of physics, it is almost unavoidable not to encounter a thought experiment especially during the revolutionary phase of scientific developments. Particularly in contemporary physics, teaching some of the concepts without referring to thought experiments, such as Einstein's elevator, Maxwell's demon, Schrödinger's cat or Heisenberg's gamma-ray microscope, became almost unthinkable. Besides, popularity of thought experiments is not limited to the domain of physics. In recent years, inquiries about practice of thought experiments in education gained popularity among science education researchers. General argument about thought experiment studies in science education literature is that, thought experiments are commonly used strategies during problem solving process and they are effective tools to gain access to implicit knowledge of students (Helm, Gilbert & Watts, 1985; Reiner & Gilbert, 2000; Reiner, 2006). However, due to being conducted in classroom environment, these studies lack details about individuals' thought experimentation processes. This necessitates individually conducted studies to detail the nature thought experiments used by students. This study intends to understand the process and nature of thought experiment used by students while solving physics problems. Three groups of participants were selected according to the level of participants' physics knowledge- low, medium, and high level groups- in order to capture the variation. Methodology of phenomenographic research was adapted for this study. Think aloud and retrospective questioning strategies were used throughout the individually conducted problem solving sessions. The analysis of data showed that thought experiments were frequently used cognitive tools for all level of participants while working on the problems. It is concluded that participants purposefully do some changes in variables or objects of the original problems during the thought experimentation processes. The results of the analysis suggested that, thought experiments used as a creative reasoning instrument for theory formation or hypothesis testing by scientists can also be used by students during the inquiry processes as well as problem solving in instructional settings.

Keywords: Thought Experiment, Problem Solving

PS.10.02.c

Strand 3: Learning Physics Concepts

Parallel Session 10.02

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D403 (3rd Floor)

Influence of different learning activities on transfer of knowledge in explanatory model construction

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Current reform proposals for improving school science learning state explicitly that students who are proficient in science should be able to "generate and evaluate scientific evidence and explanations". Nevertheless, studies, which explore explicitly how students create explanations and predictions related to specific physical phenomena (especially to those which strongly challenge common sense) are still rare. One of these is optical interaction between a light beam and a prismatic foil. When coming from one foil's side, the light beam is divided into two beams, while coming from the other, it is totally reflected. The aim of this study is explore how different previous students' practical experiences with light beams and prism interactions influence their explanations of behavior of light beam when coming in two ways to the prismatic foil.

More than 200 students of 3 Slovenian grammar schools were involved in three kinds of activity with prisms. First group only observed three experiments using three-sided rectangular prism and a ray-box laser, which were accompanied by teacher's detailed explanation of the phenomenon, as an example of »traditional methods« of teaching with minimum participation of students. Second research group got additional task to construct a predictive model for result of the third experiment, before it was actually performed and commented by teacher. In third kind of activity students were joined in small groups. They had to carry out experiments by themselves during the laboratory task, observe the results and write their findings in the report.

Approximately a week after activities took place students were tested with so called »foil test«, which is based on the problem of prism foil. Prism foil is thin transparent film, which has one flat side while the other consists of microscopic prismatic ridges [1]. Using such foil one can perform similar experiments as with prism, without revealing its structure. Students had to construct explanatory model for behavior of prism foil on the basis of observation of simple interaction between the foil and the beam of white light. In addition, every subject was tested with Lawson's Classroom test of scientific reasoning, which served as a refference test.

Results were compared to the preliminary research conducted with the prism foil. We found that overall more students solved the problem correctlly when they were included in the preliminary activity with prism compared to those without the activity. Number of correct explanatory models was stil relatively low (2,8%) but activity increased it significantly. While without the activity only students on formal reasoning level were able to solve the problem correctly, after the activity also some with lower reasoning abilities could do so. Goup with prediction activity benefited the most; progress was smaller in the lab-activity group and was not observed in the »traditional« group. Time spent on activity showed not to be the most important factor for succesful transfer.

Research results show that learning activity, which includes prediction, among the three tested helps students the most to apply previous knowledge in explanatory model construction. In the presentation results will be discused in detail, the importance of ballanced teaching approach will be stressed out and the role of correct scientific explanation during the teaching process will be adressed.

[1] Planinšič, G. & Gojkošek, M. Prism foil from an LCD monitor as a tool for teaching introductory optics. European Journal of Physics, 32(2), 2011, p. 601-613.

Keywords: explanatory models, learning activities, transfer, prism foil

PS.10.02.d

Strand 3: Learning Physics Concepts

Parallel Session 10.02

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D403 (3rd Floor)

Learning physics with the use of the forum and Cooperative Learning

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The purpose of this study was to investigate: how the use of an educational forum and cooperative learning improves student performance in learning a chapter of physics? The subjects were 120 students at a preparatory course taking an introductory course in physical engineering programs offered by a university in Ecuador. The task of teaching selected for this study included the unit: work and energy that lasted ten hours. The experimental group received instruction that would see 3 films on the topic selected, and then participate in the forum by answering 6 questions on the platform of sidweb. From the results we can see that cooperative learning is a methodology that offers improvements in student learning, in terms of motivation, greater understanding, and good interpersonal skills for learning, and is also additional support for students outside the classroom attending and answering questions with questions from them.
The use of forums and blogs education, helps ensure that the student be an active part of the learning process since they serve to complement the education of the teaching of physics, making it an important tool for active learning and cooperative work of students. The development of this virtual environment combined: the experiences of reading, observation, critical thinking and understanding. Work and are active and meaningful dialogue in the language that occur between students, the opportunity for reflective participation, creating a wake in the skills and decision-making, problem solving, integrated learning, the critical observation, and discovery learning. The ease and development, serve to foster in students critical thinking to the understanding of the important questions or physical problems. Given the results obtained according to the research and the importance of contributing significantly to student learning, there is a view of the teacher's role: is it a guide or a facilitator? And how relevant is the use of these virtual tools to supplement the formation of a freshman science and engineering.

Keywords: Cooperative learning, forum, active learning, work and energy.

PS.10.03.a

Strand 9: Teacher Professional Development

Parallel Session 10.03

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D404 (3rd Floor)

CERN Portuguese Language Teachers Programme: an 'inter-national' venture in teacher professional development

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CERN launched in 2006 its National Teachers Programmes, co-organized with the CERN member states, which complement the very successful High School Teachers (HST) summer programme, in operation since 1998. Contrary to the long and intense summer internship of 3 weeks in the HST, which necessarily runs during part of the teacher's vacation time, and to the fact that this international programme is given in English and only a few teachers per country can participate, the National Teachers Programme is more flexible, allowing for many more participants from a single member state and overcoming the language barrier. With a duration typically of one week, it can count as official professional development for the teacher, and can be properly credited if the necessary steps are taken in the participating country.

Portugal, through LIP (Laboratório de Instrumentação e Física Experimental de Partículas) and with the financial support of the Ciência Viva Agency (the portuguese National Agency for Scientific and Technological Culture), proposed a Portuguese Teachers Programme in 2007. Following the CERN indicative of a minimum number of 20 teachers (the size of the CERN bus) per programme, and after receiving more than 200 applications, LIP was able to promise CERN to send the maximum reasonable number of teachers which was considered to be about 40. After a selection procedure based on the curricula of the applicants, 43 teachers were chosen and participated in the first edition of the programme. The programme was so successful that LIP and CERN have co-organized to date 5 yearly programmes in portuguese. From 2009 on, this programme is credited by the Portuguese authorities with 1,4 credits of official professional development.

In 2009, following a request from UNESCO (through UNESCO's contact for particle physics), and with the knowledge and encouragement of the CERN Management, the programme invited teachers from Brazil and from Mozambique, resulting in a total of 60 participants and in the name change to 'CERN Portuguese Language Teachers Programme'. The participation of the Mozambique teachers was financially supported by CERN and by the portuguese Ciência Viva Agency. The selection of the Brazilian teachers was organized by the Brazilian Physics Society and financed by Ministry for Science and Technology, through its Office for Social Inclusion.

In 2010 the programme expanded further and received 71 teachers from Portugal, Brazil, Mozambique, Cape Verde and São Tomé and Príncipe, and in 2011, we finally welcomed 73 teachers representing all the countries with Portuguese as official language, namely Portugal (41), Brazil (20), Mozambique (4), Angola (4), Cape Verde (1), Guiné-Bissau (1), São Tomé and Príncipe (1), and East Timor (1). Again, CERN and the Ciência Viva Agency financially supported the participation of the teachers from African and Asian countries (except the Angolan teachers who were supported by the Angolan Government) and the Brazilians were supported by the Brazilian government and selected by the Brazilian Physics Society.

During each session, the teachers follow a very intense educational programme in modern physics (basics of particle physics, cosmology, astroparticle physics, accelerators, applied physics and detectors, data acquisition systems, medical physics), taught by Portuguese speaking scientists, and is complemented by visits to the CERN experimental facilities, including accelerators and detector installations, guided by portuguese speaking scientists, and hands-on activities. In this talk, a presentation and evaluation of the programme is proposed. In particular, the following topics will be covered:

• the rationale for the CERN Portuguese Language Teachers Programmes – aims, structure, and requirements;
• the uniqueness of the Portuguese case, that has invited participation from other Portuguese speaking countries, and the advantages of this pioneering 'inter-national' programme, i.e, for Portugal, for CERN, and for the other countries which are not member states of CERN;
• follow-up activities by LIP and evaluation of the participation in these activities;
• follow-up activities promoted by the teachers that have attended these programmes.

Besides the access to new knowledge and experiments, the interaction of the teachers of various countries with the scientists and between themselves has been intense and, as this programme is focused mainly for high-school teachers, at the return, their students have been receiving an enthusiastic and more well prepared teacher.

Keywords: international, teachers professional development, CERN, gathering nations, building bridges

PS.10.03.b
Strand 9: Teacher Professional Development
Parallel Session 10.03
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D404 (3rd Floor)

In-Service Teachers' Training Creative Physics Workshops at the National Polytechnic Institute in Mexico. A First Step

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It is a well known fact that there is a substantial worldwide decline of students´ interest in scientific subjects. As an immediate consequence of this, the number of physics students enrolling in universities continues to fall, and physics departments are closing around the world. Students prefer to choose administrative and business careers over the scientific ones. Developing countries have been the most affected by this phenomenon and the number of scientists has diminished considerably among them.
Although the situation described is a many factor problem, among the possible solutions proposed and practiced by some authors are science fairs, hands-on experimental teaching, project based teaching, etc. However, the only result obtained with these approaches has been a fleeting interest of students for science. A concrete and definite solution is required to alleviate this situation.
On the other hand, the import of educational models from developed to developing countries has not been a solution either and could somehow even worsen the local situation. Infrastructure, social conditions, GDP invested in education, etc., are some crucial problems faced when trying to implement the seemingly promising educational model to a diversity of countries at the same time.
Among the main reasons of the failure of these educational models in improving general education are the following:
• They teach the "how to", ignoring the "what to"
• Increase of population in developing world results in an even further
increase of the quantity of students in a school and in a classroom.
• Small amount of the GDP destined to education by the governments and few job possibilities for professional scientists.
While the last two problems are of a social and political nature, the first one may be solved if teachers are provided with an adequate training in the scientific subject they teach. In developing countries journalists and biologists are often found teaching physics or mathematics and many engineers are teaching scientific subjects. This is why most teachers fail to convey fully the fascination and excitement of science and hence fail to inspire young people. Boredom of students in science classes is due in part by the lack of training of science teachers.
Our aim here is to report a series of strongly contents-oriented workshops for physics teachers at the National Polytechnic Institute (IPN) led by the authors in August-September 2011 in Mexico City. Many low cost hands on activities were suggested to teachers to be used in their classes, with due account of the students' number, background and current interests. Every experiment, usually impressively counter-intuitive and challenging, was accompanied by theoretical reasoning and instructive calculations. The experience was fascinating. Participants were excited by this sort of training often giving excellent creative suggestions on how to improve the experiments and discussed how to adjust them to their specific classes. Beyond the organizers' expectations, some students volunteered to participate in the workshops and experienced a totally new way to learn physics, also taking an active part in many the demonstrations. They commented "I wish my teacher did these sort of experiments in class!"
Outdoor activities were enjoyed by all participants, in particular, experiments on the topic Amazing Physics of Elastic and Inelastic Collisions were done in the school playground, giving the opportunity to go out of the classroom and to exercise while learning physics.
At the end of each workshop a questionnaire was given to the participants to evaluate it. Absolute majority of the respondents pointed out that these workshops were just what they need to improve their teaching and noticed that pedagogical workshops are also important, but primarily they need to learn more science in order to attract students´ interest in the subject.
Our main goal now is to implement these workshops among science teachers on a regular basis at the IPN and then to all Mexican secondary schools, not only for physics, but also for chemistry, mathematics and biology.
Some of the trainees' suggestions are presented in the report as the involving live demonstrations.

Keywords: Science Teachers, Educational Models, Contents-Oriented Workshops, Outdoor Activities.

PS.10.03.c
Strand 17: Various Topics in Physics Education
Parallel Session 10.03
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D404 (3rd Floor)

Introduction of astronomy from kindergarten to upper secondary education: a holistic approach

Emmanouil Apostolakis, Sofoklis Sotiriou, Vagelis Tsamis, Eleftheria Tsourlidaki
Ellinogermaniki Agogi

Astronomy is rarely introduced in the curriculum as a stand-alone subject matter. The best scenario for Astronomy to exist as an autonomous lesson is to be optional. At the same time space-related topics are of very high interest for students of all ages, as indicated by research diachronically. Does this fact provide teachers with a first class opportunity to take advantage of students' intrinsic motive to participate in educational activities related to astronomy? Is it possible to design interdisciplinary approaches in order to engage students of all ages? These questions are addressed in this paper and the answer in both questions is a definite "yes". The main purpose of this paper is to extensively describe how Ellinogermaniki Agogi, a private school in Greece, has introduced Astronomy through various ways from its kindergarten to its senior high school. Based mainly on hands-on educational activities and following in many cases the inquiry – based teaching model Astronomy has been integrated with the curriculum of all grades. Furthermore, an extended array of additional activities have been designed and implemented in order to establish a holistic – and thus more probable to be successful – approach to astronomy teaching. Day and night educational and scientific use of an in-campus 12 meters high observatory, stargazing events far away from the light pollution produced by modern cities, remote use from students of robotic telescopes in scientific observatories around the globe in the framework of transnational cooperation (EUDOXOS, D-SPACE, COSMOS projects), teleconferences with astrophysicists, organizing European and nation-wide astronomy competitions, organizing astronomy related science fairs for students and summer schools for teachers, visiting space camps and scientific research centers, observing sun eclipses in places around the world, making hands-on experiments concerning astronomy, repeating famous ancient astronomy experiments are some examples of the above mentioned activities. There is no doubt that Astronomy is an attractive science topic for many students. The approach described in this paper changes attitudes of students towards science and relates science with everyday life. Science teaching can be more appealing and effective if Astronomy's educational capacity is fully exploited.

Keywords: astronomy, kindergarden, primary education, secondary education

PS.10.03.d
Strand 9: Teacher Professional Development
Parallel Session 10.03
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D404 (3rd Floor)

Teachers Facing Curricular Innovation Manifest Elements of Teaching Knowledge

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The purpose of this paper is to relate a study in which two middle school teachers applied a course they themselves designed in partnership with the physics teaching research laboratory of a university. The course featured topics on relativity and was made available to other middle school teachers. The course classes consisted of discussions about scientific concepts regarding the theory of relativity as well as methodological aspects related to the implementation of those discussions in middle school classrooms. The course therefore constitutes a complex challenge to the two teachers. To apply it, they must design and implement activities linked to the topic of relativity in their classrooms, discuss innovative methodologies and content, and teach their fellow teachers.
Our object in this paper is to analyze how the elements of teaching knowledge proposed by Tardif manifest themselves in interviews with the teachers giving the course. The interviews were individual but the questions were the same for both respondents. An initial analysis featured the actual questions asked during the interviews with a view to identifying what elements of teaching knowledge might be mentioned based on the questions asked. Then we analyzed the transcription of the teachers' utterances.
Our analysis provides quantitative and qualitative information regarding the elements of teaching knowledge these teachers made clear when reflecting on the classes given and when planning new meetings. The first results allow us to outline a profile for each of the respondents regarding what points they intend to focus. This makes it possible to analyze what sources of knowledge they use most frequently in their reflections. Based on our analyses we found it possible to verify that although the teachers act within the same professional context, work together, and have very similar professional and experiential backgrounds, their profiles are different. Teacher "A" is concerned essentially with physics content and its structure. The work of teacher "B" focuses the interactions that occur in the classroom and uses experience and teacher training to that end.
We also verified that teacher "B" is concerned with various elements associated with application of the classes. Such elements include, for example, the content to be worked on, the planning of activities, time allotted to each activity, and the lesson's effectiveness or lack thereof. This becomes more evident when the teacher mobilizes nearly all of the elements of teaching knowledge in the answers given during the interview. Teacher "A", in turn, focuses only on the issue of the scientific content addressed, failing to mobilize other categories of teaching knowledge when composing answers.
Regarding the elements of teaching knowledge expected in response to the questions and the knowledge manifested by the teachers in their answers, one can see that these are virtually the same with the exception of the use of a few individual elements of knowledge. In other words, in answer to some questions of the interview, the teachers specify other elements of knowledge that are not merely those one initially expects in response to the question asked. That observation serves as evidence of the teachers' reflection on their course planning and implementation actions.

Keywords: Teaching Knowledge,Curricular Innovation

PS.10.04.a

Strand 6: Secondary School Physics

Parallel Session 10.04

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D405 (3rd Floor)

Contributions from the analysis of students' learning pathways to the refinement of the design principles of a teaching-learning sequence with a model-based inquiry approach on the Acoustic Properties of Materials

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This paper presents a research study aiming to characterize 15-16-year-old secondary school students' learning pathways throughout the implementation of a teaching-learning sequence on the acoustic properties of materials (Pintó et al., 2009). Its purpose is to better understand the students' modelling processes and the design principles relating to the model-based inquiry approach of the designed teaching sequence.
As stated by some authors (Louca, Zacharia, & Constantinou, 2011), crucial information of the model-based teaching and learning approach is often missing in published research studies. This is one of the reasons why our research is intended to throw light on the process that students follow when developing three conceptual models throughout the implementation of a teaching-learning sequence with a model-based inquiry approach. These three conceptual models are intended to allow students explain and predict: (CM1) sound attenuation in materials in terms of energy distribution; (CM2) the acoustic behaviour of materials in terms of their physical properties; and (CM3) the acoustic behaviour of materials in terms of their internal structure.
In particular, the research questions that we address in this study are the following:
(1) How do students' progress from their preliminary mental models of sound attenuation in materials and of the acoustic behaviour of materials towards the intended conceptual models throughout the implementation of the teaching-learning sequence?
(2) What are the salient modelling and inquiry activities of the designed teaching-learning sequence that contribute more to the students' development of the intended conceptual models?
Drawing on the ideas of Schwarz et al. (2009), we designed the teaching sequence on the acoustic properties of materials proposing a common structure of each sequence of tasks intended to contribute to students' development of each conceptual model. This structure includes the following stages:
(1) elicitation of a preliminary mental model,
(2) revision of the mental model in agreement with new evidence obtained in hands-on or thought experiments,
(3) revision of the mental model in agreement with the scientific perspective,
(4) use/application of the revised mental model in a new context/task.
Through these stages, students are engaged in several tasks, which correspond to exploratory modelling activities, expressive modelling activities, and inquiry modelling activities (Löhner et al., 2005). Moreover, several inquiry activities (e.g. reflecting on scientifically-oriented questions, designing experiments, collecting data, drawing conclusions, and communicating findings) are also included in order to support the modelling activities.
Framing this study within the design-based research paradigm, it have consisted of the experimentation of the designed teaching sequence with two groups of students (n = 29) in their science classes. The analysis of their written productions in class allowed us to characterize the students' processes of construction of each of the intended conceptual models through several intermediate mental models that acted as 'stepping-stones'. Moreover, we could evidence the influence of the designed modelling and inquiry activities on students' development of conceptual models. Our results illustrate that the three different conceptual models involve different learning demands, which can be interpreted by taking into account the attributes of each (theoretical or empirical) model and the distance between students' preliminary mental models and the intended conceptual models. Furthermore, we conclude that specific modelling activities (e.g. inquiry modelling activities) have a greater impact on promoting students' development of certain types of conceptual models (e.g. empirical models). Implications for design and for teaching will be further described during the presentation.

Löhner, S., van Joolingen, W. R., Savelsbergh, E. R., & van Hout-Wolters, B. (2005). Students' reasoning during modeling in an inquiry learning environment. Computers in Human Behavior, 21, 441-461.
Louca, L. T., Zacharia, Z. C., & Constantinou, C. P. (2011). In quest of productive modeling-based learning discourse in elementary school science. Journal of Research in Science Teaching, 48(8), 919-951.
Pintó, R., Couso, D., Hernández, M. I., Armengol, M., Cortijo, C., Martos, R., Padilla, M., Rios, C., Simón, M., Sunyer, C., & Tortosa, M. (2009). Acoustic properties of materials: Teachers' manual & teaching and learning activities. Nicosia, Cyprus. Retrieved from: http://lsg.ucy.ac.cy/MaterialsScience/teaching_modules.htm
Schwarz, C. V., Reiser, B. J., Davis, E. A., Kenyon, L., Acher, A., Fortus, D., Shwartz, Y., Hug, B., & Krajcik, J. (2009). Developing a learning progression for scientific modeling: Making scientific modeling accessible and meaningful for learners. Journal of Research in Science Teaching, 46(6), 632-654.

Keywords: model-based inquiry, design-based research, learning pathways, teaching-learning sequence, acoustic properties of materials

PS.10.04.b

Strand 6: Secondary School Physics

Parallel Session 10.04

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D405 (3rd Floor)

Identifying student difficulties with atomic spectra

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Physics education research is still mostly focused on student understanding of basic topics from classical physics, with less emphasis on topics from modern physics. Examples of such a topic are line spectra. It is important that students develop good understanding of spectra as a prerequisite for understanding of quantum mechanics, as well as astrophysics. The structure and formation of spectra are a part of university and secondary school curricula both in Croatia and in the United States. Systematic investigation of student understanding of atomic spectra was conducted among 1000 science majors in introductory physics courses at University of Zagreb, Croatia and University of Washington, USA. A major focus of the research was on the ability of students to relate the energy levels of an atom to the corresponding discrete line spectrum. Three written questions that probed that ability were constructed, and administered to students after standard instruction on spectra. The results indicate low student understanding of the process of line spectrum formation. Most of the students failed to associate one spectral line with a transition between two energy levels, and tended instead to associate one spectral line with only one energy level. One additional question that probed student understanding of the role of the experimental setup in formation of a line spectrum was constructed and also administered to students. Only between 20 % and 30 % of the students recognized that the type of the light source is critical for the formation of a line spectrum. Identification and analysis of student difficulties guided the design of a set of new instructional materials, tutorials, to supplement instruction in a standard calculus-based physics course. The instructional materials have been validated and proved to be effective at helping students construct and apply a model of spectra formation.
Findings from the research questions will be presented, and students' most frequent conceptual and reasoning difficulties will be discussed. Students' posttest results and the examples from the tutorial will also be presented and discussed.

Keywords: physics education research, line spectrum, energy levels, student difficulties

PS.10.04.c

Strand 6: Secondary School Physics

Parallel Session 10.04

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D405 (3rd Floor)

"What Do My Students Know about Electricity and Magnetism?" Examining the Preconceptions in Electricity and Magnetism of Pre-University Students in Singapore

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Title: "What Do My Students Know about Electricity and Magnetism?" - Examining the Preconceptions in Electricity and Magnetism of Pre-University Students in Singapore.

AIM:

This study aims to examine the difficulties and preconceptions in Electricity and Magnetism of students from a pre-university in Singapore using 36 multiple-choice items from two researched-based diagnostic tool - Determining and Interpreting Resistive Circuits Test (DIRECT) and the Conceptual Survey of Electricity and Magnetism (CSEM). The reduced diagnostic instrument termed "Diagnostic Assessment on Electricity and Magnetism" (DAEM) consisted of 14 items on direct current resistive circuits (taken from DIRECT), 10 electric field items and 12 magnetism and electromagnetic induction items (taken from CSEM).

Rationale and Need for Study:

(i) Although the CSEM and DIRECT had been previously been validated for use in the States and there have been past research that had reported their use on students in countries such as United States, Canada and Germany. There have been little or no publications on the use of both instruments in the Asian context, what more than a reduced instrument. This study therefore extends the Physics education community's knowledge in the preconceptions of Asian students.

(ii) It is often not practical in terms of time constraints to have too many diagnostic instruments implemented in a school curriculum. This study therefore provides support for a reduced instrument to measure the preconceptions of students bound for university.

(iii) Most studies examining the concepts of students using the two instruments would administer each instrument twice - once in a pre-test setting and once in post-test setting to measure the effectiveness of instruction. For this study, the authors have concurrently developed new similar items based on the pre-university syllabus as well as the performance in the pre-test assessment. This study therefore also explores a parallel instrument which can be used for examination of the concepts that students have in electricity and magnetism.

Research Questions:

The research questions that this study aims to address are:

(i) What is the quality of the assessments used for assessing the conceptual understanding of students in electricity and magnetism?

(ii) Is there a difference in performance between the different subtopics (namely electricity, electric field, magnetism and electromagnetic induction) for the students?

(iii) Is there a difference in performance between the different genders?

(iv) What are the key problems or misconceptions that students have before any formal instruction?

(v) What are the problems or misconceptions after instruction?

Participants:

The participants in these are 354 pre-university (equivalent to K11 – K12) students that are offering GCE Advanced Level Physics in a top pre-university in Singapore. 100% of these students are expected to be bound for university at the end of their course. The students all had undergone some basic instruction in electricity and magnetism and their competency level for electricity and magnetism should be equivalent of students who have undergone the GCE Ordinary Level Physics. They had also had exposure to some field concepts as they had previously undergone instruction in Gravitational Fields.

Method

The DAEM was administered to the students prior to any formal instruction in the subtopics of electricity, electric field, magnetism and electromagnetism. After the lectures on each subtopic, they were given a post lecture quiz consisting of 8 to 10 items to assess their conceptual knowledge. 50 students of one of the researcher was again administered the pre lecture DAEM in a tutorial immediately following the lecture quiz to allow comparisons to be made between the performance in DEAM and performance in the post lecture quiz.

To assess the quality of tests, statistical data including the Cronbach Alpha for the test, the point biserial, the facility index and discriminatory index for each item on each assessment were computed and where data was available compared against existing publication.

The analysis of variance (ANOVA) was used to compare the percentage scores of three difference subtopics. A further examination of each item was done to specifically identify the problematic areas and the possible misconceptions of the students.

The analysis of variance (ANOVA) was also used to determine if there were any significant differences between the performance between the male and female students for the overall results, and their performances in the individual subtopics.
RESULTS:
The reduced assessment instrument, DAEM, was found to have a good Cronbach alpha values and reasonably good values in terms of the point biserial, the facility index and discriminatory index supporting the use of the reduced assessment instrument in the Asian context. On the whole, the post lecture quiz also had reasonably Cronbach alpha values, point biseral, facility index and discriminatory index as well, providing support for it to be used as an alternative instrument.
The study also found that the performance of the Singapore students to be comparable to that students in the United States, Germany and Canada. The misconceptions and the problem areas are similar in some aspects with some preconceptions that tend to be more resistant to change.
In terms of gender, it was found that there was no significant difference between the scores of the female students and male students in terms of overall scores. However, for individual subtopics, the performance of each gender varies.

Keywords: DIRECT, CSEM, High School Physics, Electricity, Magnetism, Electromagnetic Induction, Preconceptions, Diagnostic Assessment, GCE Advanced Level Physics, Misconceptions, Difficulties in Electromagnetism, Electromagnetism, Teaching Electromagnetism

PS.10.04.d

Strand 6: Secondary School Physics

Parallel Session 10.04

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D405 (3rd Floor)

The 9th graders' co-construct of representations about magnetic field of a current

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Magnetic field of a current and Lorenz force are not easy topic for secondary students because of the invisibility of field and vectorial properties. On the other hand, even though many researchers recognize the importance of social-constructivist approach that knowledge is socially constructed, empirical studies for the ways to enhance students' co-construct in science classroom are insufficient. This study aims to understand processes of the 9th graders' co-construct of representation about magnetic field of a current. Four hour teaching and learning sequences for the 9th graders have been developed to embody conjectures: introducing a big idea throughout the sequences, experiments with Prediction-Observation-Explanation strategy and visualization of directions of a current and the field by arrow stickers could help student to represent and discuss their own ideas. Students' individual activity sheets, group activity sheets of each lesson have been collected and small group activities have been video-taped and recorded with fields notes for 8 small groups of 3-4 students. Some features of students' representations about the magnetic field of a current will be reported as well as patterns of co-construction. Students' representation about the magnetic poles seemed to be confused with electric charges. They had some difficulties to represent the magnetic field around a current in a long straight wire because of the ambiguity of directions of compass needles. This ambiguity invoke argumentation among students in a group. Students' co-construction had been analyzed by two aspects; students' social roles and levels of argumentation. During the experimental activities, most of students appeared to contribute to co-construction as activity managers who started and regulated activities. Meanwhile during the explanation activities, each students had played various roles such as chairs, idea promoters, influential contributors, non influential contributors or non- responsive contributors. In most episodes, levels of argumentation appeared to be the level 2 which meant students argued their claims with sufficient/insufficient evidences but no rebuttal appeared. One episode showed the level 3 in which the rebuttal had been appeared. In that episode, the experimental data could be interpreted as various patterns and the chair student were active as well as other students with roles such as idea promoters, influential contributors, non influential contributors. In a group, one students had played her roles as a chair in authoritative ways continuously, the argumentation levels were appeared as level 2, because no other students could rebut against her. The findings could suggest ways how to organize the students' social roles especially chair as well as task to promote co-constructions.

Keywords: co-construct, magnetic field, representation, nineth grader

PS.10.05.a

Strand 6: Secondary School Physics

Parallel Session 10.05
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D501 (4th Floor)

School outreach program for teaching optics: let's start with holography

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Optics is a great opportunity to face a part of our daily experience and offers arguments suitable for effective demonstrations and for simple but not trivial explanations. Some of the most interesting topics are vision, photography, interference, holography and color.
Among these, international research points out holography as a successful teaching tool, highly motivating for experimental teaching of optics [1-4], and several papers describing how holography can be used in classroom [1,5,6] can be found in the literature. Nevertheless, in Italy, holography seems to be considered a difficult topic only suitable for university courses and requiring too expensive laboratory equipment.
In the framework of the "Piano Lauree Scientifiche " (PLS), funded by Italian Ministry of Education with the aim of supporting the teaching of sciences in Secondary Schools, we have developed a conceptual and practical path to teaching the principles of optics that are at the basis of photography and holography. The program we present is devised to help teachers and students to deepen their standard optics knowledge or to make more interesting their first approach to optics. The activity is supported by a portable set-up to make holograms with students in their schools that does not need a sand-box or a more complex vibration isolated table.
The course starts from vision, passes through photography, interference and diffraction and finally gets to holography. Actually, the topics are not strictly separated in a rigid timeline and are enriched with demonstrations. In our purposes, the experimental work is not used exclusively in a merely academic and demonstrative way or as a "closed" activity where students just follow the "steps" in a protocol, but as a useful tool for building a new knowledge starting from wonder.
During the course, students follow all the steps of the registration of both transmission and reflection holograms, including the preparation of chemical solutions for the holographic chemical processing.
The project has been proposed during the past years we have involved in the project about 200 students per year who attended not only scientific and technical curricula but also humanistic ones. Depending on the requested degree of deepening into the subject, students have been involved in eight hours of theoretical lessons supported by experimental demonstrations and eight hours of hands-on laboratory.
In our talk we will outline benefits and problems of teaching simple holography within a High School teaching curriculum.

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Keywords: optics, image formation, teaching holography,secondary education

PS.10.05.b

Strand 14: Socio-cultural Issues

Parallel Session 10.05
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D501 (4th Floor)

Measuring The Impact of Values and Identity on University Physics Learning

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This paper addresses underperformance in first-year university physics by certain groups of students, by exploring how beliefs about self affect learning. A gender gap in physics performance, with females lagging behind males, is well-known in the literature. Physics at The University of Queensland, Australia, uses teaching methods that have been shown to be effective and socially inclusive eg: interactivity and collaboration in classes, Peer Instruction [Lorenzo et al]. However, as in other places around the world, equity issues persist.

This project tests the effect on learning of an intervention that bolsters student's sense of self, using a technique recently shown to work for physics students in the USA [Miyake et al]. The gender gap was eliminated in a Peer Instruction introductory physics course. Female students significantly improved their achievement by a value-affirmation exercise, going through a process of thinking about values important to them. The theory is that those who identify with a group who are "known" not to perform as well in a particular situation experience "identity threat" when they enter that situation; if they affirm their personal values, they can cope well with the situation. Others in the US [eg: Yeager et al] have investigated groups based on gender or ethnicity, in various educational settings where students could feel anxiety about performing.

We examine the generalisability of this technique by applying it to different groups studying physics. This project investigates how susceptible to stereotype threat and value-affirmation Australian science students are. Previous work has shown that differences in cultural setting (Europe vs America) can be significant regarding student confidence in physics, while across nationalities males were consistently more confident than females [Mallow]; confidence being important for motivation of first-year students [Huang et al]. Our students arrive with a wide range of educational experience, and have diverse professional aspirations. They vary greatly in the extent to which they identify with the physical sciences. A significant fraction of students in our service courses appear to believe that physics is something that other people succeed at. They have "fear of physics", sometimes compounded by a weak maths background. We hypothesise that, like all phobias, this prevents the sufferer from fully engaging in what's going on around him/her (in this case, the learning environment), and therefore those fearful of engaging with physics learning are less likely to succeed, according to their self-imposed stereotype. Here we address the issue of increasing diversity in academic background of the student body. We ask the following research questions:

- Are Australian university students in first-year physics classes susceptible to stereotype threat relating to gender?
- Is the value-affirmation exercise proven in one physics context transferable to ours?
- Can value-affirmation improve the learning performance of those fearful of physics, perhaps because of (lack of) previous related education?

One aim of this project is to measure how strongly and how commonly various students endorse a negative belief that "other" people succeed at physics. We concentrate on investigating the confidence, attitudes and performance of students studying Mechanics – a topic that invariably features in introductory physics courses. The participants are enrolled in either PHYS1001 or PHYS1171. Each course has 100 or more students per semester, with a mix of genders. The target student identity "fearful of physics" is expected to be significant in the service course PHYS1171, where about half of the students have studied physics previously. In contrast, PHYS1001 students have chosen to study physics and tend to be academically well-prepared.

Information collection methods for the project include: data on previous education (including achievement) in physics, a survey on background and beliefs, to measure students' confidence and their expectation of success, and a well-established diagnostic test of physics knowledge pre- and post-instruction. For comparison, the protocol of Miyake et al is replicated as far as practicable. In a brief exercise at the start of usual classes, some students (randomly assigned) write about values that are important to them, while those in a control group write about values that are not personally important to them but that might be important to other people. Statistical analysis of pre- and post-test results will be presented, showing the distribution of assessment performance for control vs intervention groups, and with respect to the strength of endorsement of negative beliefs.

If the value-affirmation exercise works in this context, an outcome will be improved assessment performance in physics for at-risk groups – females and those fearful of physics. These changes occurring in students' first semester at university, they could have important implications for the rest of their study. One impact of this gateway experience might be increased retention (as attrition reduces with higher levels of self-efficacy [Reed-Rhoads and Imbrie]. Finding out whether the value-affirmation exercise is transferable to a range of situations will inform us how robust the technique is. This project could confirm a widely-applicable tool for physics educators – a strategy that affects the outlook of students in a way that results in significantly improved learning performance.

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Keywords: learning performance, student engagement, diagnostic test, conceptual understanding, equity

PS.10.05.c

Strand 14: Socio-cultural Issues

Parallel Session 10.05
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D501 (4th Floor)

Science teachers relation with social structures: an analysis of discursive interactions in focus groups based on Pierre Bourdieu sociology of education

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In recent decades the research in science education have focused increasingly in the effect of sociological processes in science teaching, and in particular in the structure-agency dialectic that characterizes the teaching practice. The present work aims to contribute to this discussion taking advantage of a theoretical contribution of great importance for the sociology of education, but still little used in the understanding of science education contexts: the Pierre Bourdieu sociology of education. To this end, we organized two focus groups with secondary science teachers in Brazil, one composed exclusively of physics teachers, and the other of teachers from other scientific disciplines. The guideline for these groups were based on the discussion of the concept of "quality" in science education, a concept that has not received enough attention in science education journals, although it resonates powerfully in educational journals. The choice of this theme was motivated by its relations with sociological processes that affect the educational system, and the posibility to interpret its incresinly importance in educational policies by Bourdieu's theory. The records of both groups were subjected to a content analysis and interpreted in the light of our theoretical framework, aimed at two main **OBJECTIVES:** (1) Identification of sociological phenomena described by Bourdieu in the discourse of teachers; (2) Characterization of the opinion of teachers about the concept of quality of education and of their specificities in science education. The results show that teachers believe they are going through a situation of reduced quality of education but, consistent with Bourdieu's theory, there seems to be a process of dissimulation difficulting the identification of structural causes for this phenomenon. Additionally, teachers showed suspicion regarding the use of the concept of quality in education, which seems to be motivated by negative experiences with proposals that were based on this concept. The characterization obtained for what actually would be a quality science education from the perspective of teachers can serve as input to proposals to promote quality education that prevents this kind of mismatch.

Keywords: structure, quality in education, Bourdieu, teachers, focus groups, content analysis, educational indicators

PS.10.05.d

Strand 14: Socio-cultural Issues

Parallel Session 10.05

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D501 (4th Floor)

Newton meets momentum currents – a passion play

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At school we teach mechanics as if in the past 300 years there had been no news. We still use Newton's language to describe mechanical interactions. When describing the gravitational interaction between the Moon and the Earth, we say –as Newton did– that the Earth exerts a force on the Moon. No reference is made to what happens in between.
It is not that Newton was so naive to believe that the space between the Moon and the Earth did not play a fundamental role in the momentum transmission. In his Principia he refused to refer to this "ether" because at his time no measurable properties of it were known. Therefore his official pronouncement: "Hypothesis non fingo". His private opinion, however was different. In a letter to the savant Richard Bentley, he clearly argued against such a view:
"That gravity should be innate inherent and essential to matter so that one body may act upon another at a distance through a vacuum without the mediation of any thing else by and through which their action or force may be conveyed from one to another is to me so great an absurdity that I believe no man who has in philosophical matters any competent faculty of thinking can ever fall into it."
We still today use the old action-at-a-distance description of the gravitational interaction. Such a description is obsolete since the first field theory emerged, i.e. the Faraday-Maxwell theory.
In our play we meet Newton personally, first in his studio, later in Heaven. We also see Newton discussing with Planck, and we hear their comments on the actual teaching of mechanics in the class-room. In this way we learn in a enjoyable manner about the adversities and obstacles that caused mechanics to remain in an outdated state till this day. Is there any hope that one day we get rid of the old concept of empty space?

Keywords: Mechanics, History, Actions at a distance, Momentum flow

Klafki's Didaktik Analysis of Specific Physics Content

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The issue of content knowledge in physics has been a focus in the teacher training programme at the School of Education University of Malaysia Sabah. Despite the Science Education Programme (Biology, Chemistry, and Mathematics) in the School of Education has focussed on improving pedagogical content knowledge, the researcher has been employing the notion of didaktik analysis for almost 5 years, to the pre-service physics teachers. Klafki's (2000) model of didaktik analysis is summarised as: What is to be taught and learned? (the content aspect); How is content to be taught and learned? (the method aspect), and Why is content to be taught and learned? (the goal/aims aspect). Here, the content and method aspects of didaktik analysis are employed by the third years of pre-service teachers to develop content-specific physics knowledge. This model of didaktik analysis has been introduced in the physics teaching methods course every semester to a number of cohorts of the pre-service physics teachers since 2008. The process of didaktik analysis includes conceptual analysis of physics content contained in the Malaysian Secondary Physics Curriculum Specification and textbooks along with analysis of literature on students' alternative conceptions, lessons plans, and teaching sequences that involve teaching and learning activities, and subsequent a reflection. The tasks of doing conceptual analysis of physics contents cover a range of topics such as force, heat, and electromagnetism. These analyses were used to develop lesson plans and developing teaching sequences which the pre-service teachers then enacted in their microteaching, and in a practicum. Studies presented here suggest that pre-service teachers participated in this physics teaching methods course valued the process of didaktik analysis. The pre-service teachers find that this experience has become a source of intellectual satisfaction, and offers greater opportunities for in-depth knowledge of physics. The use of didaktik analysis in enhancing pre-service physics teachers' practice of teaching and learning in the classroom has increased their confidence to teach secondary school physics. The pre-service physics teachers began to reflect more thoughtfully on their actions at the end of physics teaching methods course and during teaching practices in the microteaching and 14 weeks practicum at the secondary schools.

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Keywords: didaktik analysis, conceptual analysis, alternative conceptions, lesson plans, teaching sequence, reflection.

PS.10.06.b
Strand 8: Initial Physics Teacher Education
Parallel Session 10.06
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D502 (4th Floor)

Self-Criticism of Pre-Service Physics Teachers on Their CBL Usage according to Their Technological Skill Levels

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Technology has begun to take a crucial role in education. Therefore, there has been substantial effort to integrate technology into science teaching. How technology is integrated into the lessons is important because what is meant by teachers' use of technology varies widely (Bebell, Russell & O'Dwyer, 2004). The effective usage of technology is not easy for teachers. There are some barriers needed to be getting over in order to increase the effectiveness of technology usage (Wetzel, 2001). These barriers include time, assessment practices, access, vision of goals, teacher involvement, teacher apathy, training and support, rationale and funding (U.S. Congress, Office of Technology Assessment, 1995). The purpose of this study was to investigate self-criticism of pre-service physics teachers on their technology (CBL-Computer Based Laboratory) usage during lessons according to their technological skill levels. The participants of the study were ten pre-service physics teachers. The participants were trained about the usage of CBL by the researchers until the researchers convinced that all of the students could use the CBL individually. Then, they were observed one semester while they were implementing CBL technology into their teaching of various concepts such as kinematics, optics, energy, circuits and sound. After their teaching practices, a questionnaire including eight items with five-point Likert scale and one open-ended question was applied to the pre-service physics teachers in order to collect data about their technological skills. This questionnaire is composed of teachers' self-evaluations of their skills about usage of CBL technology. Technological skills of pre-service physics teachers were categorized as follows: poor, improvable and expert. Also, another questionnaire was applied to the participants to determine their self-criticism on their CBL technology usage. According to results of the study it was determined that that technological skills of two teachers out of ten teachers were improvable; other eight teachers' technological skills were in expert level. In addition, results showed that the pre-service physics teachers, whose level was expert, thought that they could make lessons more enjoyable and attractive with the help of CBL technology. Results showed that participants whose skill level was improvable determined that they had some problems about subject matter knowledge. In addition to this result, they were not comfortable with using CBL technology. On the other hand, the study presented that there were students in the class who had different learning styles, but CBL usage could not help teachers in order to take into account these differences.

Keywords: CBL, technological skill, self-criticism, physics teacher

PS.10.06.c

Strand 8: Initial Physics Teacher Education

Parallel Session 10.06

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D502 (4th Floor)

Introducing the multi-touching tablet to pre-service physics teachers

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Technology is strongly suggested to be used as a tool for helping students learn science content and science process. However, over a half of new teachers (with 3-year teaching experiences or less) felt unconfident implementing technology into their teaching (the National Center for Education Statistics, 2000). Teacher education program which intends to prepare teachers to be technology-competent should not only enhance student teachers' technological knowledge, but also build up students teachers' "pedagogical content knowledge" (PCK). Only with good connections among technological knowledge and pedagogical content knowledge can empower teacher to be effective knowledge facilitator.

In order to help pre-service teachers in physics teach with technology, this study designed a teaching method course which not only increased students' technological knowledge, pedagogical knowledge, and content knowledge, but also strengthened their abilities to design technological-infused courses. The course "Teaching Methods in Physics" was offered for senior students from the Department of Physics in a teacher college in Taiwan. It was a three-hour weekly, one-semester mandatory course. The course was mainly composed of TPCK learning (technological knowledge, pedagogical knowledge, conceptual physics discussion), software practice and design, as well as micro-teaching and evaluation.

A group of 29 senior students took the course. In order to be capable of using multi-touch tablets, each of the pre-service teachers was also provided with a multi-touch tablet during the semester. Educational simulation software were developed and presented during the course. The simulation software cannot only be used as these pre-service teachers' future teaching resources, but also give them ideas to design/select software for the topics they feel appropriate to be presented with multi-touch tablets. During the course, the pre-service teachers learn general concepts of TPACK for the target curriculum, observe mentor teachers' integration of technology into curriculum, design courses and instructional software with peers collaboratively, perform micro-teaching and conduct peer-reviews, and refine their curriculum and self-designed software.

In order to understand how pre-service teachers develop their TPCK, we will analyze their TPCK performances from their coursework, measure their self-efficacy in a technology-infusing classroom. Eight students from two target groups were interviewed, in order to know what they think about TPCK and the application of multi-touch tablets in physics classrooms, and the difficulties they encounter during the course. The quality of their micro-teaching performances and self-designed coursework will also be analyzed and cross-referenced to their performances in TPCK.

Keywords: TPCK, pre-service teachers, teacher education, multi-touch tablets, physics

PS.10.06.d

Strand 8: Initial Physics Teacher Education

Parallel Session 10.06

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D502 (4th Floor)

Measuring Pre-Service Physics Teachers' Pedagogical Content Knowledge of Momentum

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Pedagogical content knowledge (PCK) research has remained a significant area of study in science education over the past several decades (e.g., Gess-Newsome, 1998; Park & Oliver, 2007; Schneider & Plasman, 2011; Shulman, 1987). There are various definitions of PCK in the literature. Shulman (1987) defined PCK as "the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p.8). Grossman (1990) contended four essential components of PCK: i) teachers' beliefs and knowledge of teaching a particular topic, ii) knowledge of curriculum and curriculum materials, iii) knowledge of common misconceptions held by students related to a particular domain of knowledge, and iv) knowledge of particular instructional strategies and representations related to a particular topic. Park and Oliver (2007) also asserted "knowledge of assessment of students learning" as a new component of PCK. By taking into consideration these definitions, in this study, knowledge of curriculum, pedagogy, and assessment were considered as the components of PCK. Also, these definitions inform us that PCK can be understood in two ways: espoused PCK and enacted PCK. This study focused on the espoused PCK which refers to the amalgam of science teachers' knowledge of subject matter and their understanding of pedagogical strategies necessary to make a specific science topic understandable to the students. Although researchers conducted several studies in order to investigate enacted PCK which refers to observation of teachers' PCK in action during teaching (e.g., Hanuscin, Lee, & Akerson, 2011), there are few studies focusing on espoused PCK (Gardner, 2011). Therefore, the purpose of this study was to develop and test the validity of a pedagogical content knowledge assessment tool for measuring pre-service physics teachers' PCK of momentum. We choose to focus on the topic of momentum because studies reveal that many students have difficulties understanding the key momentum concepts.

The participants consisted of 18 senior pre-service physics teachers (8 females and 10 males) enrolled in a university in Turkey. In order to assess pre-service physics teachers' PCK of momentum, Pre-Service Physics Teachers' Pedagogical Content Knowledge Test for Momentum (PTPCK-M) was developed by the researchers. The PTPCK-M consists of three parts with 30 items. The first part focuses on pre-service physics teachers' knowledge of reform-based curriculum and includes seven items. The second part measures pre-service physics teachers' knowledge of reform-based instructional strategies with nine items. The third part consists of 14 items assessing pre-service physics teachers' knowledge of reform-based assessment and evaluation strategies. The pre-service physics teachers were asked to provide explanations and examples for each item considering momentum. PTPCK-M was completed in one and half hour. Students were given PTPCK-M again one week after the implementation in order to provide opportunity for them to discuss their answers to the PTPCK-M in groups of two to four. These discussions were audio-recorded.

In order to identify the statements reflecting the attributes of a sophisticated PCK and naïve PCK, two authors examined students' answers to the PTPCK-M. The two criteria were used to determine the quality of each statement and examples provided by the participants include: a focus on student-centered approaches to teaching science and the specificity of examples and strategies provided by the participants. The quality of participants' responses were graded for each question in each category based on a scale ranging from 1-5 with 1 representing the lower level of PCK and 5 highest level of PCK. Then, the participants were categorized into those that have naïve, developing, and sophisticated PCK.

The results of the study showed that most pre-service physics teachers had naïve PCK of momentum in terms of knowledge of curriculum, instruction, and assessment. For example, although the students were able to name the constructivist teaching strategies while teaching momentum, they were not successful in providing specific examples regarding how to implement these teaching strategies or how to combine these teaching strategies with nature of science, history of science, or everyday life in the classroom. The students were also not able to embed the alternative assessment techniques into their teaching of momentum. The results also demonstrated that the PTPCK-M provided opportunity for pre-service physics teachers to become aware of their weakness of PCK of momentum. It could be concluded that the PTPCK-M not only can measure pre-service physics teachers' PCK of momentum but it can also be used to make students to become aware of their weaknesses and strengths in terms of PCK. Generally, researchers assess pre-service teachers' sophistication level of PCK by conducting interviews and long-hour observations, which take lots of time. However, this study showed that PTPCK-M can be used to measure pre-service teachers' PCK. Moreover, teacher educators could use the PTPCK-M to identify the limitations, strengths of pre-service teachers' PCK.

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Keywords: pedagogical content knowledge, momentum, pre-service teachers, assessment, science education

Strand 17: Various Topics in Physics Education

Parallel Session 10.07
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D504 (4th Floor)

Educational Neuroscience and Physics Teaching and Learning

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Educational neuroscience is a new interdisciplinary research field, where traditional methods of educational research are combined with neuroscience techniques. Neuroimaging methods, such as electroencephalography (EEG), magnetoencephalography (MEG) and functional magnetic resonance imaging (fMRI), provide tools for the measurement of the brain activity of participants while they are performing a task relevant to education. Neuroscience research offers an important insight into the brain development and function. Many studies are focused on developmental disorders, such as dyslexia and dyscalculia. On the other hand, there is a wide research area on basic learning mechanisms of normally developing children and adults.

Two illustrative examples of neuroimaging studies, relevant for physics teaching and learning, will be presented. In one study, fMRI was used to determine what changes occur in the brain as the result of learning Newtonian mechanics. Different patterns of brain activation were found for the physics students and non-physics students, which provided evidence for the effects of education on the brain. Furthermore, the data indicated that the physics students inhibited their naïve thinking theory while activating Newtonian knowledge. In the second study, EEG was employed to explore proportional reasoning in adults. Proportional reasoning is an important logical skill required in physics problem solving. The results suggested that higher frequency oscillations in frontal and parietal regions are particularly important for proportional reasoning. Repeated performance of the task led to the change in brain activity pattern, suggesting that repetition led to a more automatic task performance.

Despite intriguing results from educational neuroscience, it is still not clear how to translate neuroscience research into educational practice. For sure, it is important to introduce the teaching of new findings from educational neuroscience into teacher training. On the other hand, researchers, who are typically isolated from the classroom realities, should communicate more with teachers during planning and conducting new studies. Overall, educational neuroscience is a very promising research area, in which collaboration between teachers and neuroscientists will be essential.

Keywords: Educational neuroscience, Neuroimaging methods, Newtonian mechanics, Proportional reasoning, Learning effects on the brain activity

PS.10.07.b

Strand 10: Physics Curricula

Parallel Session 10.07
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D504 (4th Floor)

Secondary School Physics Teachers' Views about the Alignment of the New Physics Curriculum with Instruction and Assessment in Turkey

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As part of the educational reform in Turkey the physics curriculum for the secondary schools was renewed in 2008. The overall goal for the physics curriculum is to help students become scientifically literate citizens. With this purpose for each unit the physics curriculum provides learning goals and limitations, suggestions for teaching methods, and assessment techniques. One of the important conditions that determine the success of the implementation of any educational reform is the alignment of curriculum, instruction, and assessment. The physics curriculum is well articulated, hence, it may be possible to align instruction with the curriculum. However, the alignment of curriculum and assessment is not technically possible because at the secondary school level state mandated exams do not exist. Instead, there are university entrance exams, which are non-mandated ranking exams that are used to place students into universities.

Teachers are in a unique position for implementing curricular changes: how teachers enact the curriculum is closely related to what they think of the alignment of the curriculum, instruction, and assessment. However, there are few studies that describe teachers' views about the new physics curriculum in Turkey. The purpose of this study was to explore teachers' views about the goals, content and structure, and the assessment approach of the new physics curriculum and how well these components are aligned. The study was designed as a qualitative multiple case study. The participants were 39 physics teachers employed in 27 different state schools in Istanbul. Data were collected using semi-structured interviews and were analyzed using constant comparative method.

The data showed that almost all of the teachers viewed the aim of teaching physics as preparing students for the university entrance exams. For many teachers the physics curriculum of the 9th grade was shallow and was based mostly on narrative, whereas the curricula for the 10th and the following grades were too technical and dense. Most of the teachers did not change their methods of instruction; they were lecturing and solving multiple choice problems instead of doing experiments. Most teachers stated that the real measure of achievement was not the assessments at school but the university entrance exams. Many of the teachers expressed that the curriculum change would be in vain if the questions in the university entrance exam are not based on the new curriculum.

The results support the conclusion that in Turkey physics teachers have their own view and implementation of alignment among learning goals, instruction, and assessment. It appears that the entire process of teaching physics is guided by the university entrance exams. Teachers cannot conceive how experiments would be assessed in the exams and hence they do not perform experiments. One implication of this study is the need to align the university entrance examinations with the learning goals in the physics curriculum. Such alignment has the potential to become the driving force for implementing the new curriculum.

Keywords: curriculum alignment, educational reform, physics curriculum, teacher views

PS.10.07.c

Strand 10: Physics Curricula

Parallel Session 10.07

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D504 (4th Floor)

Efforts to Improve an Undergraduate Program and Curriculum

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Ongoing efforts to overhaul and improve the undergraduate program and increase the enrollment and retention of undergraduate majors at the Physics Department of Kent State University in Ohio, USA, will be presented. The revised program is based on a new curriculum, new introductory physics labs, new student advising structure and creation of an environment of community and belonging for physics majors. The new curriculum aims to prepare students not only for entry into the graduate school but also into the industrial/high-technology sector. The traditional math courses beyond the introductory two-semester, ten-credit-hour Calculus sequence (like Linear Algebra, Ordinary Differential Equations, Partial Differential Equations etc), required for upper level Physics courses, have been consolidated into a two-semester, eight credit-hour total sequence on Mathematical Methods in the Physical Sciences. The yearly, six-credit-hour sequences on Classical Mechanics and Electromagnetic Theory have been also consolidated into single four-credit-hour semester courses. The consolidations offer our students a wide range of elective-course options and enables them to customize their curriculum towards either a research or a professional track. New courses, like Materials Physics, Applications of Modern Physics, Data Analysis and Computational Physics Techniques, Cosmology, Biological Physics, Biophotonics, Electromagnetic Waves and Optics, and Mathematical Methods in Physics have been introduced. All students are required to work on a research project through an academic year or summer Internship (for credit). An overhaul of both College and University Physics Laboratories was also implemented by introducing inquiry-based activities based on recommendations of Physics Education Research. A background pilot study on the feasibility of converting the introductory physics course to an integrated one has been conducted with positive feedback from the students. The efforts of our Department appear to have doubled the number of graduating physics majors, meeting the 2008 recommendation of the American Physical Society to double the number of Physics bachelors in the US.

Keywords: Undergraduate Program, Undergraduate Curriculum

PS.10.07.d

Strand 10: Physics Curricula

Parallel Session 10.07

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: D504 (4th Floor)

Engaging Large Enrollment Classes for Pre-Service Elementary Teachers in the Practices of Science

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In the United States new science standards are being developed that focus on both content and practice [1]. These standards will be based on the Framework for K-12 Science Education developed by the National Research Council [2]. Among the scientific practices that will be emphasized are carrying out investigations, analyzing and interpreting data, developing and using models, constructing explanations, and engaging in argument from evidence. Because of this focus it is important that science courses for prospective elementary teachers provide them opportunities to learn science content while engaged in these practices. Several curricula have been developed over the past twenty years in the United States for university students that accomplish this, including Physics by Inquiry [3], Powerful Ideas in Physical Science [4] and Physics and Everyday Thinking [5]. However, all these curricula are intended for classrooms with relatively small enrollments (usually 36 or fewer students) and in settings where students can work in small groups fully engaged in hands-on experimentation and discussion. However, because of budgetary and staffing constraints, many universities can only offer large enrollment courses for this audience. There is a need for curricula that can be taught in large class settings, yet still engage students in the practices of science. The purpose of this paper is to describe the development of such a course, called Learning Physics (LEP). Its development is being supported by the U.S. National Science foundation [6].

The 'Learning Physics' curriculum has been piloted at the author's institution during fall 2011 and spring 2012 in classes for 120 students. To promote group discussion, at the beginning of the semester students are assigned to groups of four, sitting at a fixed location in the large classroom. For half of the semester, when topics are covered that are not feasible for students to conduct hands-on experiments at their desktops, the instructor shows video clips of demonstrations and experiments and poses multiple-choice questions for students who use hand-held automatic response systems ('Clickers') to make predictions, draw conclusions from evidence, interpret representations, apply ideas or evaluate explanations [7]. For the other half of the semester students work in groups at their seats with materials and conduct experiments on their desktops. A main focus of these hands-on activities is for students to use experimental evidence to develop, test and/or revise models to explain phenomena. 'Clicker' questions are used periodically to enable groups in the class to share observations and conclusions. Generally when these questions result in nearly equal distribution among two or more answers, students are called on to share their thinking in front of the whole class. These whole class discussions are intended to help focus students' attention on the practice of argumentation, and in particular on supporting claims with evidence and reasoning. To engage students in the practices of constructing explanations and evaluating explanations of peers, we use the web-based Calibrated Peer Review system, developed at UCLA [8]. In the presentation I will briefly describe and show examples of each of the ways we engage students in the practices of science, and provide some evidence of its effectiveness (data being collected during spring 2012). We see our work as informing instructors who are constrained to teach large enrollment classes, but who also want their students to engage in the practices of science.

[1] Achieve, Inc. Next Generation Science Standards. Retrieved from the web on 10 Feb, 2012 at http://www.nextgenscience.org/.
[2] National Research Council. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (National Academy Press, Washington, DC. 2012).
[3] L. C. McDermott, Physics By Inquiry, Vols. I and III (Wiley, New York, 1996).
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[6] National Science Foundation Grant 1044172. The work described in this paper has been supported by that grant.
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[8] M. Walvoord, M. Hoefnagels, D. et.al. An Analysis of Calibrated Peer Review (CPR) in a Science Lecture Classroom. J. Coll. Sci. Teaching 37(4), 66-73 (2008).

Keywords: scientific practices, pre-service elementary teachers, physics curriculum, writing explanations, large enrollment classes

PS.10.08.W

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 10.08 Workshop

Date & Time: 05.07.2012 / 14:10 - 15:40

Room: Smart Class

Modelling and Data-Logging in Teaching Physics - ICTforIST Project

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Many claims have been made about the benefits of using educational technology. However, as research studies have demonstrated, the impact of educational technology in schools has not transformed learning and teaching substantially so far. Consequently, a majority of teachers does not yet exploit the creative potential of technology and do not engage students more actively in the learning process. Considering that technological tools alone are far from sufficient, there is need for a combination of tools and appropriate curricular materials as well as eligible social and physical settings. Thus, there is agreement that teacher training should not just encompass technological skills but rather a full understanding and complete mastery of technologies as pedagogical tools.

Within the ICT for IST project, which was funded within the Leonardo da Vinci programme of the Life Long Learning Programme of the European Commission, exemplary ICT-driven curriculum materials together with support materials for teachers' professional development were designed and tested. The developed materials include a guide for science teachers and teacher trainers and a series of modules on physics, chemistry and biology containing activities illustrating how data-logging, video measurement, modelling, and simulation facilitate scientific inquiry and students' development of problem-solving skills. Additionally, the materials include commentaries intended to develop teachers' pedagogical understanding about ICT - enhanced teaching and learning in science.

The workshop will focus on highlighting the additional pedagogical value of supplementing and extending laboratory experience with data-logging by integrating interactive simulations as powerful tools for learning physics concepts as well as tools allowing an intuitive approach to the modelling of dynamical systems. Furthermore, ideas how to use the ICT for IST materials by physics teachers, teacher trainers and science educators will be shared. Workshop participants will have an opportunity to examine the resources, to try out some of the activities and to discuss the effectiveness of designed teachers' professional development courses. Finally, the ICT for Innovative Science Teachers (ICT for IST) pack, which presents a series of modules containing classroom activities and illustrating how to use data-logging, modelling, simulation and video measurement in science teaching, will be distributed to all workshop-participants.

Keywords: Modelling, Data-Logging, Teaching Physics, ICT for IST project, supplementing and extending laboratory experience, teachers' professional development

PS.10.09.W

Strand 3: Learning Physics Concepts

Parallel Session 10.09 Workshop
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D505 (4th Floor)

MUSE workshop Session 2 Experiments with scanner: relative linear motion

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Target audience (about 20): physics teachers and teacher educators at any school level.
The main objective is to highlight the design of educational activities around simple experiments that would be necessary in order to go beyond invoking mere excitement, and would aim at maximizing students' conceptual understanding. To this end, the workshop will illustrate the "MUSE" approach (an EPS-PED project:
http://education.epsdivisions.org/muse/). The main idea is that, simple to perform as they may be, many experiments with ready-made materials deserve detailed reflection if they are to be used as a focal point for promoting meaningful learning.
During each session of the workshop, we will present an example of a "simple" experiment in order to engage the participants in discussion around the key ideas of the MUSE process:
- the need for conducting an in depth-content analysis in direct comparison with students' common ideas and difficulties;
- the importance of reflective awareness of teaching rituals and the shortcomings involved in constraining teaching to routines without resorting to careful and specialized design;
- the educational value of elaborating conceptual links both within and between activities, as well as with situations from everyday life.

Workshop Outline:
We shall start with a brief introduction to present the MUSE core ideas (about 10 min). Then the participants will be invited into a series of activities on relative motion in one dimension (about 50min). These activities will be carried out in small groups that will work in parallel on the same tasks. We shall start by mentioning some typical difficulties that students have with relative motion followed by a short explanation of how scanner works (5 min). The main part of the workshop will require active engagement of the participants in analyzing, solving and discussing problems that have been designed based on the scanned pictures. There will be emphasis on using multiple representations, such as labeled images, diagrams, graphs and analogical examples.
A whole group discussion will follows (about 25 min), in order to share the experiences gained in the small groups, and envisage the transfer of the workshop to different audiences (students, teacher educators).
All participants will receive detailed document for this experiment, including sheets directly usable in the class to be adapted to different contexts.

Keywords: Conceptual learning, simple experiments, teacher education, relative motion, computer, scanner

PS.10.10.W

Strand 17: Various Topics in Physics Education

Parallel Session 10.10 Workshop
Date & Time: 05.07.2012 / 14:10 - 15:40
Room: D506 (4th Floor)

Make your own context based tests

Anneke Thurlings, Pieter Smeets
Cito, National Institute of Test Devolpment, Arnhem, The Netherlands

In the Netherlands we have had a context based exam curriculum in which specific contexts have been prescribed since the 80s. Because of the principle: "test what you teach", all exam questions are context based. We think that knowledge on Physics is only relevant within a context and therefore context is important for the education of a pupil.
Every test is built around 5 or 6 subjects, each around one context. A context contains 4 to 7 questions. The test covers most of the concepts and contexts of the curriculum. All pupils of one level make the same test on the same day at the end of their school career.
Each year we construct new tests and after the exams, these tests are free to use for everyone.
In this workshop we will show you some examples of contexts which we used in the previous years. The hyperlink below will show an example of an exam in 2010.
Every test is constructed by a group of 4 physics teachers and an assessment expert. The teachers work for CITO one day a week. Their task is to search for useable contexts and reliable information about the subject. They make a proposal for a subject, so that every question is relevant for the context. The questions have to be totally independent so that they can be answered without knowing the solution to previous questions. The test construction process takes several years and only then the test can be used in an exam.
In the construction group the proposals for questions are discussed in-depth and approved for further use. The assessment expert constructs the final test and is responsible for the end result. The two workshop leaders are both leaders of a construction group and they will teach you the DOs and DON'Ts of constructing context based tests.
In the Netherlands we also have test projects with the specific purpose of exploring the possibilities of constructing computer based tests. In this workshop we will show you some examples of these types of questions.
In the so-called Compex-project we constructed tests in which pupils did their own measurements of a movement on a video fragment and explored the results with dynamic models.
In the pre-vocational education we use applets and make specific simulations for use in computer based tests.
After our introduction we will ask you to construct your own questions in groups, based on a given context. After that, we will discuss the results.
Please join our workshop, so next year testing will be more fun for you and your pupils.

http://www.cito.nl/static/ce/ex2010_havovwo/bestanden/HA-1023-f-10-1-o.pdf

Keywords: context based test, computer based tests

JULY 6, 2012
FRIDAY

PS.11.01.a

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 11.01

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D501 (4th Floor)

Developments of Active-Learning on Blowgun Systems Using ICT Tools with Milliseconds Resolution for Better Conceptual Understanding on Mechanics

Akizo Kobayashi, Fumiko Okiharu
Fuculty of Education, Niigata University, Japan

We are developing various innovative approaches for science education by using ICT tools with milliseconds resolution for rapidly moving phenomena that were difficult before to observe with naked eyes, e.g. observation of rapid blowgun movements and those of rapid falling phenomena, and rapid collisions phenomena, etc. And it is because of that those rapid movements are now become to be easily analyzed and to be clearly observed by using such high speed movies camera as Casio EX-ZR100/ZR200 (with 120, 240, 480 and 1000fps) and sensors systems (motion detectors, current and voltage probes), etc. [1]
We now present some specially developed ICT based active learning [2] modules of blowgun darts systems in frictionless and frictional worlds for deeper understanding of core concepts in physics education. It is noted that we can realize idealized frictionless motions by blowgun darts system in the pipes of acrylic plastic and we can investigate Newton’s laws of blowgun systems by changing length of the pipe and strength of the pressure in the pipes, etc.
We report on active learning modules on laws of terminal velocity in frictional world of the blowgun pipes, where we get terminal velocity by changing the size of acrylic pipes and darts and also by changing pressure in the blowgun pipes.
We also show useful active learning modules for deeper understanding of the mass concept in a weightless world by observing 2-body pendulum collisions using high speed movies camera with millisecond resolution. Furthermore, we are assessing the effect of these active learning [2] modules using wireless response systems (WRS) as polling tools for getting maximum effects by inviting and engaging students in interactive learning environment.

ACKNOWLEDGMENT
The authors are supported by Grant-in-Aid for Scientific Research (B) (21300289) and (23650503) and Young Scientists (B) (21700785).

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Keywords: high speed movies camera,milliseconds resolution, active learning module, blowgun darts system, conceptual understanding

PS.11.01.b

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 11.01

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D501 (4th Floor)

Teaching physics through online forum discussions

Anne L Scarinci
University of Sao Paulo, Brazil

Introduction

The most usual (and traditional) design of distance education courses (DEC) involves a weekly problem to be solved – for which the student should use provided text material, plus forum/chat discussions with tutor and other participants. In this design, teaching occurs mainly through forum and chat. These are, therefore, the spaces where conceptions, doubts and errors appear and construction of knowledge takes place. Our investigation lies in the strategies tutors attempt to use in order to promote learning.

Theoretical framework

Many authors have identified teachers' actions and strategies to promote science learning in regular classrooms. Some investigations were also carried out as to understand strategies used especially to help students construct physical models and to handle with preconceptions.

Along with actions designed directly to promote learning, there are a number of other actions teachers utilize to address affective issues – such as fostering interest and enthusiasm for science and dealing with fear of exposing oneself – as those also play an important role in science learning (Lemke, 2001).

Strategies in distance education may be different from regular classrooms, but should address similar objectives (Giannasi, 2005). Also, we expect specificities in a virtual learning environment when the physics content is involved.

Rationale and methods

Tutors are the actual teachers at a DEC; we seek to learn about the pedagogical knowledge they have. This research intends to identify tutor interventions in online forum discussions and their objectives to promote learning.

Data was produced from 5 classes of a professional development DEC in Physics, offered to teachers. Each class had a tutor and 20 students. All tutors were qualified teachers. We analyzed the forums during the theme "some causes of color".

Results

Most of the posts included explanations given by the tutor. The explanations varied in nature:

- further empirical phenomena was brought as ground for conceptual analysis ("in this image, you can see that deep sea has a different color from shallow water…")
- conceptual explanation was used in a way as to exemplify physical modeling ("So, if I imagine the wave arriving at a molecule, the electrical charges in there will oscillate…")
- tutor discussed the use of technical terms as a means to deepen the concept ("Why can't we use 'reflection' in this case? Because the emerging wave does not follow the specific laws of reflection…")
- tutor addressed possible misconceptions ("Many people think the blue ocean color is due to reflection of the sky; however in this image [link] we see a cloudy white sky…")
- further explanation was given after correct answer, either as to deepen learning or as a sort of "prize" for accomplishment ("Perfect! Now you can understand that the blue color of veins is also explained by scattering…")

In almost all posts, tutors included an explicit or implicit dialogical element, such as a question or a suggestion of study or investigation. In four instances, participation of other students was explicitly requested (in others this was not explicit). Only 13 times (out of 76 interventions analyzed) a question was posed without a preceding explanation, although 43 posts included questions.

Most questions were of conceptual type, i.e. asked for an explanation or interpretation ("Why do you say it is due to absorption?"). Others were empirical ("And what color is a single grain of sand?"), seeking participation ("So, does everybody understand what Marco wrote?"), or attempting to find out which model student is using ("When you say that the blue light collides with air molecules, how would you explain why red light does not collide?")

Affection interventions occurred 21 times and included: acknowledging achievement, expressing enthusiasm, fostering participation and dealing with possible inhibition or lack of confidence.

Conclusions

Tutors had a constructivist approach to learning, which is inferred from their dialogism and effort to connect concepts with empirical observations and to explain/foster interpretations by the use of physical models, when aiming to arrive at concepts.

Nevertheless, much explanation was given. Tutors did not wait for clear expression of a conception before providing further empirical data or explanation. This may have 4 possible explanations: i) the forum is not a synchronous mean of interaction and there's no time for too many back-and-forth utterances before conclusion is reached; ii) students seek answers and not further questioning and tutors are preventing decrease of participation; iii) tutor does not wish to expose student; iv) students do not access the forum so often that a different strategy would work.

In spite of the many-to-many dialogism characteristic of the forum (as preconized in the literature), interaction happened mostly in a one-to-one basis. We do not understand if this is a limitation of this specific group or a general characteristic of this context, where the physical content is involved and it is expected that the tutor will be the capable person to address doubts and provide knowledge.

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Keywords: online distance education, teacher's strategies, constructivism

PS.11.01.c

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 11.01

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D501 (4th Floor)

Using Smartpen technology in an active learning lecture setting to observe and characterise student discussions

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A variety of active learning techniques are becoming widely used in the teaching of physics at university level. One of the most popular is Peer Instruction (PI), which seeks to use lecture time to promote discussion about physics concepts amongst small groups of students. This has been shown to promote conceptual understanding, as the peer discussions address student understanding at a level compatible with the students' own current position and in their own language. Previous studies of the effectiveness of PI have examined the content of student discussions, or have quantitatively examined changes in student understanding due to those discussions, but not both of these factors together. (Changes in student understanding are usually diagnosed using pre- and post-discussion voting, usually by means of 'clicker' technology.) There is then an open question on how the various characteristics of these student conversations might influence learning gains.

The aim of this study has been to attempt to characterise relevant features of student conversations associated with successful and unsuccessful PI sessions. Understanding these features might allow instructors to promote techniques which facilitate more effective discussion and hence greater learning gains. We have observed the behaviour of around 20 of our first year introductory physics students during a whole semester's PI lectures using Smartpens: these are electronic pens which capture in synchronisation what the students write and an audio recording of their immediate environment. This technology allows us to observe authentic student behaviour with minimal perturbation. Successful and unsuccessful PI episodes were identified by examining pre- and post-discussion votes for the entire class.

We find that low gains in understanding tend to follow conversations which focus on surface features or irrelevant details in the posed PI conceptual questions. Such conversations also tend to feature limited use of technical language. In contrast, conversations which seem to facilitate large gains in conceptual understanding can be characterised by a rich and varied use of appropriate technical language. These observations have implications for the design of peer instruction questions and activities: the conceptual questions may be most effective if their structure or use of language permits activation of the appropriate problem space and technical vocabulary. Since PI depends so strongly on students vocalising and defending their ideas, failure to develop clear and unambiguous methods of communication is likely to hinder expression and development of scientific reasoning during these sessions.

Keywords: Peer Instruction, Problem solving, Physics, Smartpen.

PS.11.01.d

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 11.01

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D501 (4th Floor)

Uses of Video Analysis for Teaching Introductory Physics and an Exploration of its Effectiveness in Helping Students Understand Projectile Motion

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Video clips of various motions can be recorded, transferred to a digital computer, subjected to computer-based capture and frame by-frame data analysis using sophisticated software packages such as COACH, Tracker or Logger Pro. The LivePhoto Physics Group in the USAi has been developing curricular materials based on video analysisii and also exploring the impact of digital video analysis and other instructional methods on student understanding of projectile motion. The purpose of this talk is to: (1) present an example of how research can be designed to assess the impact of digital video analysis on student learning at the postsecondary level; (2) discuss preliminary results of a study of student understanding of graphical representations of projectile motion; and (3) describe some unusual uses of video analysis in introductory physics teaching.

Video capture and analysis is being used by instructors in the USA to improve student understanding of projectile motion in many settings including lectures, tutorials, laboratories, homework, student projects and web-based assignments. Although there has been a recent study of high school student conceptions about projectile motion,iii there have been no studies at either the secondary or postsecondary level of student ability to relate descriptions of projectile motions to their graphical representations. This is an ability that computer-based video motion analysis should be uniquely suited to enhance.

In order to study the effectiveness of video analysis in this topic area the LivePhoto Physics Group has developed a pre/post test instrument known as the Projectile Motion Conceptual Evaluation (PMCE). Preliminary results will be presented on an ongoing study of the impact of various instructional approaches on PMCE gains for over 1000 students enrolled in 50 introductory physics classes. The instructional techniques explored include how instructors use video analysis to teach projectile motion, the style of instruction (e.g. traditional lecture/lab vs. active learning), and whether projectile motion is introduced during the study of kinematics or after Newton’s Second Law is presented.

The talk will end with a description of unusual non-mechanics applications of video capture and analysis to other topics introduced in the Group’s recent publication entitled Physics with Video Analysis.ii These include: (1) relating the P-V cycle of a heat engine constructed with a medical syringe to the useful work done by the engine; (2) verifying Coulomb's Law; (3) visualizing the characteristics of Faraday's Law of Induction; and (4) quantifying the Doppler Effect for sound waves in air and surface waves in water.

Keywords: Video analysis, projectile motion, student learning

PS.11.02.a
Strand 3: Learning Physics Concepts
Parallel Session 11.04
Date & Time: 06.07.2012 / 09:00 - 10:30
Room: D505 (4th Floor)

High school students analyzing the phenomenology of superconductivity and constructing model of the Meissner effect

Alberto Stefanel, Marisa Michelini, Lorenzo Santi
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Superconductivity offers many opportunities to explore a relevant phenomenology very interesting for students because perceived as a challenge that stimulate the construction of models, activate a critical re-analysis of their knowledge about magnetic and electrical properties of materials, stimulate links between science and technology, thanks to really important applications (i.e Maglev Trains, supermagnets for physics research and MNR test), offers bridges from classical to quantum physics [1-2].
In the European projects MOSEM 1-2 [3], an educational path was developed on superconductivity in the high school, integrating it in the curricular courses of electromagnetism. The educational path developed implement an IBL approach using a set of hands-on/minds-on apparatuses designed with simple materials and High Technology, YBCO samples, usb probe to explore resistivity versus temperature of solids [4]. The educational pathway suggests an exploration of the Meissner effect to recognize his peculiar character with respect of the ordinary interactions between two magnets, between a magnet and ferromagnetic, paramagnetic, diamagnetic systems. The interaction of a magnet and an ordinary conductor (a tube or a thin layer of copper), in particular when eddy currents produce relevant feedback on the magnet, activates the role of the superficial eddy super-current in a YBCO, linking magnetic and electric properties in superconductors, then deepened analyzing the breakdown of the resistivity in a YBCO cooled in LN with a USB probe [4]. The Meisser effect, first described on the phenomenological level [5], is then framed in the BCS theory qualitatively introduced. A phenomenological analysis of the pinning effects and of a maglev train model stress on the different phenomenology and application of superconductors.
Several implementations where made in Italian high schools with more than 500 students.
Here we document the results of two research experimentations carried out with 40 and 41 selected students 17-18 aged, where they were involved using tutorials in personal and free explorations of the Meissner effect. The following research questions address the research carried out on students learning: What are the models that students spontaneously activate in the description of the phenomenology of superconductivity? How role play field lines and magnetization vector in their analysis of the Meissner effect? What are the students learning processes analyzing the phenomenology? What are the knots on which are focused their learning problems?
The tutorials was analyzed categorizing the students' sentences and drawings. The students learning paths evidence evolution from spontaneous model (based on the magnet-magnet like interaction) to a progressive recognition of the diamagnetic properties of the superconductors. These results are produced by the active and collaborative learning environment stimulated by the tutorials used and supported by the strong motivation created by the challenge phenomenology. These preliminary results evidence the feasibility of an introduction of superconductivity in high school, indicating also the way to modify the educational path and suggesting new researches on students learning.

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Keywords: Superconductivity, teaching/learning, upper secondary students

PS.11.02.b

Strand 3: Learning Physics Concepts

Parallel Session 11.04

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D505 (4th Floor)

Superconductivity at high school: minimal requirements and implications for teaching/learning electromagnetism

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Superconductivity is a rich and complex topic that however generates great interest and curiosity in high school students. Most of the presentations of superconductivity for high school students naturally give a great importance to magnetism. But typically in these presentations the physical role is played by the magnetic field B, whereas the vector potential A is seen solely as a mathematical tool [1]. Also in important projects such as Mosem [2], quantitative theoretical descriptions are often not enough developed or sometimes given at a popular level. In this paper we present, as a part of a more general project on the teaching of superconductivity, what we think to be a key tool in a consistent description of superconductivity i.e. the vector potential A. We focused our research on the definition of the minimal requirements necessary to build a theoretical explanation of the experiments that students perform about superconductivity, such as the Meissner effect and the measure of the critical temperature of a superconductor of type II. We inspired our sequence to the "two fluid theory" of the London brothers (1935) [3] and to the Pippard phenomenological description of superconductivity (1954) [4]. Starting from a phenomenological description of electrical conduction based on the relationship $J=\sigma E$ we move forward to get the parallel with the relation $J_s = -kA$, where Js is the super-current flowing in the superconductor and k is a positive constant. Despite the introduction of the vector potential A could appear challenging, we think it gives also an important way i) to review some aspects of electromagnetism and ii) to prepare the student to topics of quantum physics different from superconductivity, such as the Aharanov-Bohm effect, in which A cannot be replaced neither by the magnetic field nor by the electric one. We presented our teaching/learning sequence to two groups of students very different in their motivation, knowledge and in their ability in physics and mathematics. The first group was composed by students which voluntarily chose to attend this advanced course that was performed in extracurricular hours at the University of Milan. The second group was composed of students of an high-school classroom and lessons were held in curricular hours. In the first context the sequence was of about 24 hours, in the second was of about 10 hours. Being the groups extremely different in their composition a comparison between them would be no significant, so we especially focused on the results gained after the sequence by each of the two groups. To get an evaluation of the conceptual understanding of the students, we used detailed oral interviews, written tests given during the lessons and a questionnaire used to support the students in the lab-room.

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[3] F. London and H. London, Proc Roy. Soc London A149, 71 (1935).
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Keywords: superconductivity, electrical conduction, vector potential, teaching/learning sequence

PS.11.02.c

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 11.04

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D505 (4th Floor)

MPTL Evaluation Report of Multimedia Resources on Electromagnetism

Francisco Esquembre, Leopold Mathelitsch, Bruce Mason, Ewa Debowska
MPTL Board

Every year, the MPTL board carries out an evaluation of multimedia resources for teaching and learning a particular field of Physics.

We will report on this year's evaluation, which covers the field of Electromagnetism.

We will also report on the board meeting and announce and present the location and dates for next year's MPTL conference.

The session is open, so every body is welcomed to attend, even if not an MPTL member.

Keywords: MPTL, multimedia, resources, electromagnetism

PS.11.03.a

Strand 13: Philosophy, Nature, and Epistemology of Science

Parallel Session 11.03
Date & Time: 06.07.2012 / 09:00 - 10:30
Room: D504 (4th Floor)

Understanding the Nature of Science and Nonscientific Modes of Thinking in Gateway Science Courses

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BACKGROUND:
There are important problems for students entering gateway science courses such as the language and epistemology of science are akin to a foreign culture. For many students in the introductory gateway course, although individual words are understandable, the sentences appear to take the form of an unknown language. A second major problem is that students enter gateway science courses with certain preconceived beliefs about the nature of science knowledge and learning. Thirdly, most students have no notion that science could be learned more effectively yet in different ways other than how they usually learn it.

PURPOSE:
The purpose of this study firstly, is to help students to recognize the importance of concepts in learning physics and secondly to get students to change their learning approach to situate concepts within a framework. Thirdly, to get them to review all their concepts and ask how they fit into the framework presented in the textbook and by their instructor. To meet these objectives, we have developed a suite of activities, the Reflective Writing Tool, the conceptual-conflict collaborative group exercises and the critique writing exercises.

METHOD:
The study is a three-year long research project. The first year of the study (2011) examined in this paper consisted of two parallel pilot projects conducted in a single country. In 2012 the study will be expanded to three institutions in that country and institutions in four other countries. During the pilot testing two sections at each institution were taught by the same instructor. Each one of these courses lasted for one semester (13 weeks) and ranged from a relatively small (N=32 students) to a large course (N=100 students). The courses used different textbooks and had different formats. The experimental group was exposed to all of the activities and the control group was only asked to perform summary writing of textual material before coming to class. The study examines the scientific epistemologies and students' approach to learning before and after they have experienced the above-mentioned interventions. It employs a mixed-methods study design combining quantitative (pre and post tests and student writing products) and qualitative data (interviews). Rubrics have been designed to examine reflective writing, critiques and interviews that are later subjected to qualitative analysis. The interviews probe students' epistemic beliefs, and their views about and the nature of science, whether their views have changed, and, if they have, the students are asked what brought about these changes. These interviews are audio or videotaped and transcribed. For pre- and post-tests of the scientific epistemologies respectively, we used the Lawson Test of Scientific Reasoning (A. Lawson, 1978; A. E. Lawson, 1992, 1996) in the pilot studies and are using Discipline-focused Epistemological Beliefs Questionnaire (Hofer, 2000) in the next phase. For the physics content test we used the enhanced version of the Force Concept Inventory (FCI) (Hestenes, Wells, & Swackhamer, 1992). All of these instruments have been validated with the intended population. At the end of the course the same Final Exam was administered in both sections.

RESULTS:
When the final examination scores between the experimental and control groups were compared no significant differences have been found. Next the results of General Linear Model analysis revealed that the Final Exam scores depend on the pre-FCI scores and on the teaching method. Lawson pre-test scores have not been found to have a significant impact on students' Final Exam score. We found that controlling for the pre-FCI scores and Lawson pre-test, the experimental teaching method has been found to have a significant positive impact on students' Final Exam scores. The independent variables (pre-FCI and teaching method) explain about 36% of the Final Exam variance.
Also after evaluating 11 writing products, we noticed an improvement in students' competence over time in the fluency of the writing in the student's own words and in their ability to identify that some ideas presented in the textbook are in conflict with the students' own ideas and then also to discusses the conflict in experimental groups. There was also an improvement in formulating questions and addressing their own questions. Most of the students performing reflective writing were able to formulate questions and some of

the students addressed a question. None of the students doing summary writing noted conflicts with the students' own ideas. In doing the critiques, faced with scenarios taken from two different frameworks, all but one of the students were able to justify the point of view of their framework.

CONCLUSIONS:
Analysis of the results based on the rubrics showed that the students in the experimental group were able to identify concepts and relate them to previously studied concepts within the course and to their own life experiences. They came to the realization that some ideas/facts/data presented in the textbook are in conflict with the students' own ideas and then also to discuss the conflict. Most of them were also successful in discussing the conflict. Both the interviews and the student writing products indicate that students who were part of the intervention groups have undergone a shift in their thinking about physics and physics learning. Moreover, the way they approach studying physics indicates that the students change their way of learning due to their exposure to these activities.

Keywords: Scientific epistemologies, students' approach to learning

PS.11.03.b

Strand 13: Philosophy, Nature, and Epistemology of Science

Parallel Session 11.03
Date & Time: 06.07.2012 / 09:00 - 10:30
Room: D504 (4th Floor)

The importance of Chi's ontology tree and conteptual metaphors in physics education

Havva Sibel Kurt, Musa Sari
Gazi University

The goal of this study is to present a theoritical framework to explain the role of spoken and written language in physics. We will use this framework to understand types of meanings students may construct from language and difficulties. We will adopt Etkina and Brookes's (2007) view that students encounter and participate in representations.
The idea of metaphor can be traced back to Aristotle in his "Poetics" (Aristotle, 1932). Metaphor is for most people a device of the poetic imagination and the rhetorical flourishment--a matter of extraordinary rather than ordinary language (Lakoff & Johnson, 1980).
Many human concepts are represented metaphorically has been the central claim emerging from research on conceptual metaphor, a trend of research in cognitive linguistics (Lakoff & Johnson, 1980). Broadly, cognitive linguistics is concerned with identifying how lexical and grammatical options in language are associated with subtle variations, generalization, imagistic simulation and metaphorical mapping. An important emprical finding emerging from linguistics (Lakoff, 1987, 1990, 1993; Lakoff & Johnson, 1980; Lakoff & Turner, 1989). Researches have shown that physicists use analogical models to construct new ideas (Hesse, 1996; Nersessian, 2002). These anological models become, in time encoded linguistically as conceptual metaphors (Sutton, 1978).
Etkina and Brookes (2007), have identified three types of anological model that metaphors encode. These can be classified by their origin and function:
Some Examples:
1. Current Anological Models: Electron --> is --> Wave
2. Defunct Analogical Models: Object A --> "heat" flows from A to B --> B
3. Descriptive Anologies: Potential Energy Graphs --> are --> Water Wells
Examples of how the metaphor that encode anologies 1-3 by identifying the base of the anology (Gentner, 1983).
Over time, the elements of theory became encoded in the language of physics as conceptual metaphors. Note how the modern ontology is in direct conflict with the caloric ontology of thermodynamics.
It has been suggested that humans divide the world into ontological categories of matter, processes, and mental states (Chi at al, 1994):
Matter --> Living --> Non-Living
Processes --> Procedure --> Event --> Constraint-based interaction
States --> Mental States --> Physical State
Etkina and Brookes, hypothesize that the concepts in a physical or anological model can be arranged into an ontological tree similar to the one proposed by Chi et al. It is necessary to modify Chi et al.'s ontology tree to accommodate one missing category, namely, physical states.
Chi et al. have shown that many student misconceptions are based on students's incorrect ontological classification of physics concepts. Students are failing to coordinate appropriately the many different descriptions that they learn from physicists' language.
In some cases difficulties may be related to linguistic models that students have developed prior to instuction. We suggest that some student difficulties may be attempts to negotiate the meaning and applicability of different linguistic models.
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Keywords: Chi's ontology tree, conceptual metaphors, physics education

PS.11.03.c

Strand 13: Philosophy, Nature, and Epistemology of Science

Parallel Session 11.03

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D504 (4th Floor)

Planet Definition and the Nature of Science

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There are many differences between experts of philosophy of science about how science works. However, there are some elements that are applied to contemporary literature that underlie today which means the idea of science. Among these attributes, there is the provisional nature of this knowledge, which does not originate by simple observation, but has a theoretical load associated on its construction, is influenced by the social and cultural context and is produced by creative acts of imagination allied to the methods of scientific research (Lederman et al., 2002; Chalmers, 1990).

It is believed that students would become more critical about this knowledge if these characteristics of science were discussed in science education. In order to contribute with subsidies to promote a better understanding about the scientific knowledge construction in education, inspired by the change in categorization of the ex-planet Pluto (IAU, 2006), that had great repercussion in the media and it still is subject of controversy, we made a research, that has, initially, a documentary nature, rescuing the principal episodes in the history of the planet definition and establish its relation with characteristics of the nature of science.

The episodes involving the "definition" for the planet throughout history show some characteristics of the nature of science.

The mobilizations and the divergences elapsed to resolve and to formalize what are the attributes of a planet, discussion heated by the discovery of object 2003 UB313, informally but popular known as Xena (Foust, 2006), show, for example, that there is no consensus among members of the scientific community about some of its resolutions and that this knowledge is in construction process, an opposite view to a possible closed and dogmatic conception of science.

In addition to this, it can add the fact that in 1999 would have been occurred a first attempt to change the status of Pluto, without success. A decision based on the trial that keep it as a planet would not harm anyone and would avoid confusion among students and teachers around the world (Mello, 2010). This episode illustrates how cultural and social factors can influence the organization of scientific knowledge.

The various changes of some categories of celestial bodies according to the model of the universe – geocentric and heliocentric (Weintraub, 2007), illustrate the transitory and temporary nature of scientific knowledge. Such as the cases of Ceres and Pluto, that had their classifications changed due to some implications resulting from discovery of asteroids around them.

And finally, when we follow the events surrounding the discovery of new celestial bodies, highlights the cooperative nature of scientific work. The importance of the contributions of Percival Lowell and William H. Pickering for the discovery of Pluto illustrates this fact (Stern & Mitton, 1998). This perception may favor a less individualistic and elitist vision of science, avoiding the belief that a science developed by isolated geniuses.

These propositions indicate the potential use of these episodes in education, with the aim of promoting a greater understanding of the nature of science. It is expected that clarify such relationships can contribute with subsidies to promote a better understanding about the scientific knowledge construction.

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Keywords: pluto, nature of science, planet definition, astronomy teaching

PS.11.03.d
Strand 13: Philosophy, Nature, and Epistemology of Science
Parallel Session 11.03
Date & Time: 06.07.2012 / 09:00 - 10:30
Room: D504 (4th Floor)

The nature of physics

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Recently, the nature of science has gained more attention through the ultimate objective of having generation with better understanding of scientific literacy. Aspects of nature of science have become focus of the explicit way of stimulating students' understanding about science. Studies based on the aspects promopted discussions on the empirical and tentative nature of science; the role of creativity and social factors in science; the differences between data and evidence, observation and inference, theory and law. These discussions on the aspects of nature of science is indifferent to the role of mathematics and deductive methods in physics. The little emphasis on deduction and more emphasis on induction bring out two questions "Which ways of doing science are important in physics?" and "What aspects of science should teachers discuss in physics lessons?" The purpose of this paper is to discuss aspects of nature of physics and provide examples from history of science.
Nature of Science literature does not give a clear definition of the role of mathematics in science. Since physics is thought as integral with the mathematics in order to comprehend nature of physics, the role of mathematics should be clearly defined. A review of history of physics shows that axiomatic method, mathematical deduction, geometry were heavily used in scientific studies. Mathematic was the main component of the most of the scientific studies besides experiments and observations. Even, analogies or thought experiments were concluded with the mathematical explanations and mathematical models.
Studies in electricity are based on experimental studies which heavily depend on measurements that show relation between variables. Although this is not completely wrong, information about history of electricity shows that there are other scientific methods besides experiments. Famous scientists investigating electricity and magnetism used scientific methods; such as mathematics, analogies, demonstrative induction and visual reasoning.
The concept of electric potential has a long history which covers approximately 200 years. During this process scientist used various methods to discover and explain concept of electric potential. The major thought for electric concept was fluid theories. Thinking electric current as a fluid, pressure or tension of the electric fluid was considered. Although observation of (working on) the electric flow was not as easy as observing flow of water, there were some kinds of devices to make measurements and make some conclusions. English scientist Henry Cavendish was first to study flow of electricity through experiments and these experiments were the first step in the concept of electric potential (Cavendish 1921, Maxwell 1873). As many scientists were interested in, mathematicians were also keeping up with the progress of the concept of electric potential and finally they handled the subject in 19th century. Mathematical equations were developed by French mathematicians following the foundation of theoretical and empirical bases of scientists. Mathematics was the second step in development of the concept of electric potential.
Although concept of electric potential was concluded by mathematicians it became more comprehensible with the attempts of Thomson and Maxwell. They tried to theorize concept of electric potential by using analogies. They analogized the flow of electric charges to the flow of heat and flow of water. Heat and water were good examples to explain the flow of electric charges. Moreover, the mathematical equations were appropriate to studies on electric. Maxwell put emphasis on analogy with his words "little similarities among laws of physics help to explain another" (Simpson 1997).
A less-known scientific method, Demonstrative Induction can be given to exemplify methods that were used in history of electricity. Coulomb used Demonstrative Induction on his way to investigate electrostatic attraction. Coulomb did not conduct a large number of experiments or observations to formulize law of electrostatic attraction; instead he started his studies after writing down the formula. Coulomb believed that all bodies had to obey Newton's law of attraction, so inverse square law for the objects should be valid for electrified bodies. Strong theory of Newton, that Coulomb based his theory on, enabled him to infer a theory of electrostatic attraction from limited number of empirical data and avoid him to make unreliable intuitivist generalizations (Dorling 1973). Coulomb hypothesized by using existing assumptions and supported his hypothesis with experiments; in other words, he hypothesized that electrified bodies obey the Newton's general law of attraction and made comparatively limited number of experiments to support his hypothesis.
In conclusion, aspects of the nature of physics should emphasize the role of mathematics and geometry, objectivity of mathematics, the nature scientific laws with mathematical deduction. In physics lesson, deductive and mathematical aspects of nature of science should be given besides inductive and empirical apsects.

Keywords: Nature of physics, history of physics, scientific methods

PS.11.04.a
Strand 16: International Perspectives
Parallel Session 11.02
Date & Time: 06.07.2012 / 09:00 - 10:30
Room: D502 (4th Floor)

STEM Education international: the ESTABLISH project

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Background
In 2010 14 Partners from 11 European countries started working together building links between Companies, Engeneering, Schools, and Home (ESTABLISH) During the project teaching and learning IBSE units, which are informed by scientific and industrial communities, will be developed and tested. Appropriate supports for both in-service and pre-service teachers to implement IBSE will be included. The project is coordinated at Dublin City University.
It brings together the key communities in second level science education to work together to create authentic learning environments to drive change in classroom practice.
These communities include:
(1) science teachers and educators, including science teacher networks;
(2) the scientific community, both local enterprises and multinational industry as well as the scientific and industrial communities;
(3) the students of science in second level schools;
(4) the parents of these students;
(5) the policy makers responsible for science education at second level, including curriculum developers and assessment agencies and
(6) science education researchers.
Methods
The project consortium have adopted an agreed definition of inquiry/elements of inquiry as the "intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments"
(Linn, Davis and Eylon, 2004). Using this definition and arising from extended group discussions, the individual elements of inquiry were identified. Teaching and learning units have been developed by the consortium to be used in teacher education – both pre-service and in-service – that are good examples of IBSE.
An agreed framework for the development of an IBSE unit has been developed by the consortium that requires the developers to describe:
(1) Unit/science topic,
(2) IBSE character,
(3) Pedagogical Content Knowledge,
(4) Industrial Content Knowledge,
(5) Learning Path(s) and
(6) Student Learning Activities and Classroom Materials.
Using the framework, central IBSE units are developed with contributions from several project participants and through piloting in each country by the consortium members working with teachers. The central unit is then adapted for implementation in each country, taking into account cultural and curriculum difference.
The criteria for each ESTABLISH Unit is that they conform to the ESTABLISH definition of Inquiry Based Science Education (IBSE) and encourage and facilitate students to be active learners. The units must be representative of IBSE and inspire teachers to generate their own IBSE materials. These units should link to real world/industrial applications. Specific attention should be given on gender issues ensuring that all materials are suited to both genders.
The topics of the first units are: Disability (focus on Biology), Invisible holes (Chemistry) and Sound (Physics). The second cycle included the topics: Heating & Cooling; Chitosan; Electricity & Electronic components; Cosmetics & Blood donation, the third cycle will focus on: Photochemistry/Light; Renewable Energy; Surfactants; Light; Chemistry for Life; Polymers; Forensic Science; Medical Imaging & the Process of Science. These topics show the broad approach towards the aim of the project.
Results
After creating the three examplary units in 2011, they were tested at different levels (students - teacher students at university - in-service-teachers) on national and international level. The results show a great consensus of the teachers and of the consortium on the attractivity for students as well as a great acceptance through in-service and pre-service teachers.
The results were collected by questionnaires and evaluated on national and international level.
They show, e.g., a greater acceptance of Biology-orinentated content in comparison with Technical / Physics content, a result we knew from various previous studies on interest in science subjects. However, the embedded presentation of such content seems to create a high acceptance even of these topics. We tried to measure the level of acceptance as well as on university students as on pupils level. Teacher students are the prospected STEM-teachers, what do they think about STEM, IBSE and the embedding of Physics and

Engineering into their Biology classes? Detailed results will be presented at the conference.
As ESTABLISH has a special view on the collaboration of stakeholders, one focus lies on the collaboration between schools and companies. It is not jet experienced very much, how to organize such collaboration and keep it sustainable, as several approaches to establish such collaboration lasted only for a few years. So one focus of research lies on the collaboration between schools, teacher education and companies of the technical and science field. What are elements of successful cooperation? Results of this study will be presented at the conference.
Conclusion
This presentation shows an international IBSE approach of integrated science modules which combine the natural Sciences and Mathematics to teaching/learning modules relevant for students. The results of the first testing cycles will be presented as well as results of research of collaboration between schools and companies in the STEM field.

Keywords: STEM-Education, IBSE, International Consortium, EU-Project ESTABLISH, Collaboration School-Companies, recruitment in STEM

PS.11.04.b
Strand 16: International Perspectives
Parallel Session 11.02
Date & Time: 06.07.2012 / 09:00 - 10:30
Room: D502 (4th Floor)

"STELLA - School for Training in Experiments with Lasers and Laser Applications": a novel approach to high-level education

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We present the activities of "STELLA - School for Training in Experiments with Lasers and Laser Applications" that took place at the Insubria University laser-laboratory premises, in Como, Italy, from June 20 to July 9, 2011 [1]. Similar events were previously hosted by the Laser Research Center in Vilnius (2007), the FORTH Institute of Electronic Structure and Lasers in Heraklion (2008) and the ICFO Institute for Photonic Sciences in Barcelona (2009) [2].
During three weeks of full immersion activities, several cutting-edge experiments in linear, nonlinear, classical and quantum optics were staged directly in research laboratories, for training purposes. School participants were PhD students and Post-docs coming from all over the world. The action was devised to provide each student with 120 hours of intensive training, organized in 8 hours of plenary sessions, a curriculum of two separate 32-hours technical courses and a 48-hours training in scientific writing.
The original aim of the School was to build a permanent European network capable of supporting the sharing of state-of-the-art of technical know-how among the laboratories active in the field. The demand of such a joint effort in education follows from the increasing complexity of lasers, diagnostics, measurements and modeling techniques, which makes several small-size laboratories not adequate to cover the necessary training program for the young employed personnel.
STELLA School has proposed to the scientific community a highly innovative approach to training and research, which de-emphasizes competition among the laboratories in favor of true enhancement of knowledge levels. The action targets the establishment of long-term, stable synergy in training and research by creating a high-level technical know-how shared among the European young scientist community.
The driving idea behind STELLA is simple, being the same one that has seeded the birth of Universities in the Middle Ages: the inherent unity between research and education. The proposed concept of "School" stems from the experience that "a discovery begins when two or more people start sharing it."
To this end, STELLA has challenged students, professors, assistants and local organizers to set up original experiments and computational works, thus tackling the achievement of genuine scientific results along with the realization of a didactic route.
Among the novelties of STELLA, we point out the last week of the course devoted to paper writing: students, professors and local contacts were jointly involved in writing a scientific paper on the results achieved during the School. The resulting papers were peer-reviewed and published in the volume 199 of The European Physical Journal Special Topics [3].
Notably, the output of evaluation questionnaires directed to students and professors is also reported and discussed in the Issue, as a relevant contribution for a short-term evaluation of the project [4].

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Keywords: laser, training, experiments

PS.11.04.c
Strand 16: International Perspectives
Parallel Session 11.02
Date & Time: 06.07.2012 / 09:00 - 10:30
Room: D502 (4th Floor)

A Study of Current and Desired State of Physics Education in Iranian Female Secondary Schools

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This study has examined the characteristics of physics teachers, their professional competences, supplies of equipments and technologies, appropriate textbooks and motivational factors in students' learning of physics from female physics teacher's points of view. The population included all female physics teachers in Isfahan city and a total of 88 teachers were selected as sample of study. The study was a descriptive survey that used researcher made questionnaire consists of 46 items. Cronbach's alpha coefficient for this scale was set to be.95. For data analysis, descriptive statistics, t-tests and ANOVA test were used. The results showed that in the present state, physics teachers have a low level of scientific knowledge. In terms of professional skills, their abilities were average and educational equipments and technologies were available at low level. Moreover the satisfaction of female physics teachers of books and educational texts was moderate. Meanwhile, the motivation for learning the lessons of physics was moderate. Also the results in desired state showed that all components of study could be effective in learning physics. Accordingly, it is recommended to enhance learning and teaching physics education, school should be equipped to supplies and technologies for teaching physics, including virtual laboratory. In the current state, "motivational factors for learning physics" has the highest average and "equipment and technologies in physics teaching" has the lowest average. It is may be due to that motivational factors are internal factors that drive students to learning physics automatically. Also various reasons such as lack of credibility could be cause of deficiency of educational equipment and technologies in physics education. According to results of study, the greatest difference is between current and desired state of third components (technologies and equipment in physics education). Furthermore the minimum difference is observed between the current and desired state of second components (motivational factors for learning physics). Therefore it is recommended to reduce this gap, improve motivational factors between students and increase technologies and equipment to teach physics in virtual environment.

Keywords: Education, Science education, Physics education, Current state, Desired state, Secondary education

PS.11.04.d

Strand 16: International Perspectives

Parallel Session 11.02
Date & Time: 06.07.2012 / 09:00 - 10:30
Room: D502 (4th Floor)

Innovating Science Teacher Education by the TEMPUS-Project SALiS

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SALiS (Student Active Learning in Science) is a project funded within the TEMPUS program of the EU. SALiS involves partners from Germany, Bulgaria, Ireland, Moldova, Georgia and Israel. The purpose of the project is innovating science teaching by implementing modern and effective strategies in science teacher education. The focus of innovation is strengthening inquiry-based science education with a high degree of student activity, hands-on and minds-on.

The presentation will outline the theoretical framework of SALiS. On the base of this framework, science teacher training modules and materials were developed and applied in SALiS-trainings in all the beneficiary countries. Teacher training modules were implemented into the teacher training curricula in the beneficiary and the EU-countries. The curricula will introduce prospective and in-service teachers to well established practices of inquiry-experiments, open labwork, problem-solving activities and forms of collaborative and cooperative learning. Innovations in the beneficiary countries Moldova, Georgia and Israel were also touching reform by implementing infrastructure for more hands-on and laboratory activities in pedagogical course in teacher training, and implementing the culture of low-cost- and microscale-experimentation in science teacher training by equipping respective labs accordingly. Exemplary information will be provided about the selection of the chosen innovations. An overview on the resources developed will be given.

At the end of the presentation a short outlook will be given about the experiences of developing and implementing innovations in physics and science teacher training in Georgia, Moldova and Israel. Successes and desiderata will be discussed.

Keywords: Active learning, inquiry based science education, teacher training, laboratory activity, low costs experiments.

PS.11.05.a

Strand 17: Various Topics in Physics Education

Parallel Session 11.05

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D506 (4th Floor)

Testing student understanding of basic concepts in electricity

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Results from physics education research on student conceptions indicate that there is often little change in conceptual understanding before and after formal instruction. Based on findings from peer-reviewed publications the author develops a valid and reliable diagnostic instrument, for quick and efficient detection of students' alternative comprehension of basic electricity concepts. Although multiple-choice questions are widely used instruments for assessing student understanding, care is needed when interpreting students' responses, as correct answers can be false indicators of student knowledge and understanding. However, two-tier multiple-choice items, based on students' answers to essay questions and other open-ended questions, facilitate the relation of students' answers to what they actually know and understand. The paper reports on preliminary findings based on two-tier test items to measure student understanding of 'current consumption', 'battery as a source of constant current' and 'viewing an electric circuit as a system'. A 30-item test, including 11 two-tier items with answer and reason tiers to measure students' content and explanatory knowledge, was administered to 422 students (225 female, 197 male) of grade 7 to grade 12 from middle and high schools across Austria after formal instruction. To get the score for a two-tier item, a value of '1' was assigned when both responses were correct. Furthermore, by examining specific combinations of answers other relevant variables were calculated to address students' misconceptions. For representing the reliability of the test, difficulty levels, which ranged from moderate (.57) to high (.11) as well as internal consistency, given by Cronbach alpha (.84), were used. As eight different alternative conceptions in the context of basic electricity were identified, the findings suggest that the conceptual understanding test is useful in diagnosing the nature of students' misconceptions related to simple electric circuits and therefore, can serve as a valid and reliable measure of students' qualitative understanding of simple electric circuits. Furthermore, some quantitative techniques such as confirmatory factor analysis and structuring equation modeling revealed that the test scores could be a valid and reliable understanding of the correlation according to different misconceptions. In conclusion, the research program focuses on figuring out specific relationships between different misconceptions and making the test instrument applicable both for physics education research and the teachers in the measure of students' qualitative classrooms. On the one hand, the final test instrument can aid teachers in formative and summative evaluation of their teaching. On the other hand, the instrument can be an applicable resource for physics education research as well.

Keywords: electricity concepts, valid and reliable diagnostic instrument, two-tier items, student misconceptions, resource for physics education research

PS.11.05.b

Strand 17: Various Topics in Physics Education

Parallel Session 11.05

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D506 (4th Floor)

Physicists in the mist: an outsider's view of research learning

Serene Hyun-Jin Choi, Timo A. Nieminen

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One of the purposes of the BSc in physics is to train future physicists. However, BSc graduates are not yet at a professional standard; the undergraduate degree provides a foundation, and a key part of research training is in postgraduate research. While the PhD program is an essential part of this learning process, it is also highly individual and there is no standard curriculum for PhD training.

One consequence of this is that research methods such as those used in anthropology or ethology (Fossey 1983) can be both appropriate and useful. In addition, an anthropological approach can give an outsider's view. What the insider accepts as "just normal" can seem quite remarkable to the outsider (and while gorillas will generally remain oblivious to such insights, the human insider will sometimes share this opinion after some thought, as noted by Zaslavsky (1994), on African counting systems).

One important question relates to difficulties faced by international students. International research students provide an important part of the research manpower in some Western countries, and international students provide a pool of potential PhD students beyond a limited domestic supply. The bulk of research on international postgraduate students has focussed on difficulties faced by non-native English speakers when writing theses; such research typically deals with students in business and economics, or social sciences. The applicability to physics is open to question, and investigation of this applicability requires an understanding of disciplinary differences. Similarly, the applicability of other related research rests on the extent of disciplinary differences. Therefore, one of our aims was to study the particular features of research learning in physics, and differences from other disciplines. Our other aims were to investigate differences in research learning between domestic and international students.

Very early in this study, it was very clear that there are major differences between research learning in physics and in some other disciplines. For example, in Arts and Humanities, it is common for the student to conceive the PhD project, then approach potential supervisors. This tends to lead to a very different manner of work, isolated in comparison to the collaborative environment typical of a research group in physics. Indeed, in physics, the PhD thesis is often not the major product of the PhD project; instead, research papers published in journals are the primary communication of results and can have more impact on future employment that the thesis. As a result, writing the thesis is not such a key obstacle as seen in other disciplines.

International students do face some challenges compared to domestic students. Visa restrictions and fee structures can make timely completion much more important for international students. In addition, international students do come from different institutions, each with their own cultures which can differ in important ways from the local institutional culture. However, the experience of international students has much in common with that of domestic students, and recommendations for how supervisors can support their research learning are generally applicable to supporting domestic students as well.

Overall, we have found that an anthropological/ethological approach can yield significant insights into the features of the group under study. In this case, the outsider's view was especially valuable for revealing discipline-specific features of research learning, and for examining supervision behaviours and their impact on research learning by students.

Fossey, D. (1983). Gorillas in the mist. Boston: Houghton Mifflin.

Zaslavsky, C. (1994). "Africa Counts" and Ethnomathematics, For the Learning of Mathematics 14(2), 3-8.

Keywords: Research methods, anthropology, international research students, disciplinary differences

PS.11.05.c

Strand 17: Various Topics in Physics Education

Parallel Session 11.05

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D506 (4th Floor)

Analysis of right and wrong answers of concept tests by Item Response Curves

Genaro Zavala

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This contribution presents a technique for assessing diagnostic concept tests in physics. The main question is how I can use Item Response Theory (IRT) to analyze, not only the right answer, but also wrong answers. This contribution is based on the Item Response Theory (Hambleton et al., 1991) which focuses on items modeling the response of a person with a specific ability. There are plenty of contributions regarding IRT in the literature but most of them focusing on psychology. This contribution is also based on all literature on research on students understanding of concepts. The conceptual understanding of physics has become one of the most prolific areas of research in physics education research. Students have preconceptions, scientific explanations of the phenomena that surround them, which sometimes obstruct learning, acquisition of scientifically accepted explanations. There is also plenty of research contributions in the literature in student understanding that has resulted in research-based concept tests like the Force Concept Inventory, FCI (Hestenes et al., 1992), Brief Electricity and Magnetism Assessment, BEMA (Ding et al., 2006), etc. Concept tests are multiple choice question tests that are an efficient way to evaluate a large number of students because they are easy to administer and analyze, regardless of the number of students. Some analysis has been developed to validate the tests and to understand the results. The Item Response Theory through Item Response Curves has given a new vision of these tests for the characterization of the correct answer, something that is very well established. However, most of studies have focused their analysis on the right answer. This contribution is important since it will analyze the wrong answers as well. This is possible because questions were constructed with several models that students have and those models are evaluated in the question. This analysis of right and wrong answers can help teachers or researchers to better comprehend the understanding of concepts by students. In conclusion, this contribution gives researchers tools to analyze multiple choice questions in a concept test which is in a development state and help teachers and researches to analyze results of well-developed concept tests to better assess students.

Keywords: IRC, Concept tests, conceptions

Testing students' conceptual understanding in geometrical optics with a two-tier instrument

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Light is an important part of everyday life. We daily encounter various different optical phenomena. Despite extensive experience with light, understanding geometrical optics turns out to be difficult for students. Physics education research of the last decades shows that students hold numerous conceptions about optics which differ from scientifically adequate concepts (Duit 2009). These alternative conceptions turn out to be extremely persistent. Efforts to transform them through regular instruction into scientifically accepted ideas have proven to be partly successful (Andersson and Kärrqvist 1983, Fetherstonhaugh et al. 1987, Galili 1996, Langley et al. 1997).

Research on alternative conceptions in optics has mainly used the methods of interviews or questionnaires with open answers (Andersson and Kärrqvist 1983; Driver et al. 1985; Guesne 1985; Jung 1981; Viennot 2003). In addition to these quite time consuming methods of investigation some multiple-choice tests were developed (Bardar et al. 2006; Chen et al. 2002; Chu et al. 2009; Fetherstonhaugh and Treagust 1992). These tests focus on various age-groups and on different content areas within geometrical optics. We have, however, not found a psychometric valid test instrument designed to portray basics conceptions in geometrical optics of students on the lower secondary level.

Most existing optics tests use a simple multiple choice structure. With this time-saving way of assessment it is not always possible to identify students' misconceptions as thoroughly as with interviews. As a result, we decided to use a two-tier multiple-choice structure for our instrument. There, each item consists of two tiers. The first part of the item includes responses with known student alternative conceptions. In the second part of each item, students have to justify the choice made in step one by choosing among several given reasons.

Our main research objective is the development of a two-tier multiple-choice test which is able to portray lower secondary students' conceptions in geometrical optics. Our aim is to tailor the test for two different purposes. On the one hand, the test shall be used for physics education research purposes e.g. to evaluate students' conceptual learning. On the other hand, the optics test shall support teachers in their formative assessment of students' learning processes.

This paper presents the first steps of the development process. So far, a first version of the optics test mainly consisting of items taken from literature was developed and tested on-line with 14 year olds (N>650). Based on results of this first phase the test was revised and tried out in a paper and pencil version with 14 year olds after conventional instruction in optics (N=367).

The results of the first test version showed that several of those items taken from literature and existing tests did not work well for our age group. The forms of visual representations used (pictures, drawings, …) as well as the fact that some items were quite text-intensive posed problems for students. The results of the first test version gave also several hints that students had severe problems in grasping basic optical concepts (vision and light propagation).

Findings from this first phase were integrated in a second version of the test. A first analysis of the results again shows students' severe problems in understanding the mechanisms of light propagation and vision. Although all students had instruction in optics beforehand common sense ideas about vision like those found by Guesne (1985) seem to be prevalent.

The analysis of the second test version shows on the one hand that the test is in general able to portray several types of students' conceptions known from literature well. On the other hand, results indicate that some items need still revision and improvement. Finally, items focusing on ideas like image formation by lenses or shadow formation, need to be integrated in the current version to get a more complex picture of the interaction of different conceptions. These findings will be included in a next version of the test.

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Keywords: Geometrical optics, developing a two-tier test instrument, key-concepts in geometrical optics, geometrical optics concepts of beginners, alternative concpetions in geometrical opitcs

PS.11.06.a
Strand 1: ICT and Multi-Media in Physics Education
Parallel Session 11.06
Date & Time: 06.07.2012 / 09:00 - 10:30
Room: D404 (3rd Floor)

Active learning electromagnetism with iPhone, iPod Touch and iPad: a new teaching resource

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The proliferation of so-called smart phones (among which we include the iPhone) and tablets (iPad and iPod Touch) is leading to these devices to be focused by teachers and researchers. Their power of calculation and their graphic capabilities make them to be extremely attractive for trying to increase the process of teaching and learning in a highly significant manner. Smart phones and other similar devices provide new ways of learning that we believe it is necessary to explore. They are also adequate tools to be considered as possible alternatives or complements to the traditional classes.
These devices have also the possibility of being interconnected among them either connected through Internet, and doe to this the range of possibilities they offer is really hard to imagine. The connection can be synchronous (voice calls, short messages with special applications to communicate the iPhones, …) or asynchronous (e-mail, social networks, blogs, forums, short text messages,.). We are at the beginning of a stage, with an open-mid door and a powerful glow can be seen through the slit. Who does not dare to open that door?
Through three commercial applications that it is possible to download in an iPhone, iPod Touch or iPad from the App Store at a price at 0.79 € and 1.59 € (1 or 2 dollars) we propose the use of these devices as tools for learning electromagnetism with first-year students in university. The programs (Apps) that we describe are those we find the most interesting between more than one hundred options, which have been developed for studying electromagnetism. These three Apps are "ELECTROMAGNETISM Solver", "FORMULARY: PHYSICS Pro" and "PHYSICS by Hanz Meyer".
We will show different screens for each of the three aforementioned Apps and we will insert comments on the physics aspects that we consider most interesting for each of them. Finally we would like to point out that a correct operation of the applications requires having the latest version of the software available.
It can be concluded that these programs are useful for making some concepts of electromagnetism more attractive to college students because they allow search and understand, in a very interactive way, some physical concepts which are displayed in a very visual manner. Maybe this is the near future that awaits us if we want an active learning by our students.

Keywords: ICT, Electromagnetism, Multi-media, Physics Education, University Physics, Iphone, Ipad, Itouch

PS.11.06.b

Strand 16: International Perspectives

Parallel Session 11.06

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D404 (3rd Floor)

Problems and prospects of Physics Education in Bangladesh

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Bangladesh is a low human developed country with HDI of 0.50 with a rank of 146 out of 187 countries. Compared to other developing countries it has a highly dense population with a low Adult literacy rate (54%). Science education in general is less popular compared to business studies because of demand in job market. Women represent 48% of the total population. Percentage of women in physics (30%) in Bangladesh is quite satisfactory and comparable with many of the developed countries. Although women scientists and researchers are hard working, creative with high intellectual capability but they are still underrepresented and discriminated in the policy making positions of scientific profession and education (Gender Inequality Index 0.55). Social, scientific and technological advancement of a nation can only be strengthened through equal participation of men and women. Bangladesh has no alternative to using physics as a tool for improving people's living standards and for dealing with economic and environmental challenges. To meet the challenge of ever-growing power crisis and to reach the coastal area, solar energy is an appropriate solution. For this research in solar energy, Physics graduates are very much needed.

Climate and global warming is a major issue of the day and as such research in atmospheric physics in the context of Bangladesh weather (earthquake, rainfall, storm, cyclone, tsunami etc.) is needed. Demand for Physics Graduates cannot be undermined when Bangladesh has signed MOU with Russia for Nuclear Power Generation. Research in this regard will involve mainly high level physicist specializing in nuclear and reactor physics. Present study investigates status of physics education and career in Bangladesh and its impact on future of S&T in the country and also a global comparison in this respect.

Keywords: HDI, physics graduates, environmental challenges, global warming, nuclear power.

PS.11.06.c

Strand 1: ICT and Multi-Media in Physics Education

Parallel Session 11.06

Date & Time: 06.07.2012 / 09:00 - 10:30

Room: D404 (3rd Floor)

University Physics Education using Facebook

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The European Space for Higher Education, pushed by the Bologna process, demands a change in the way the courses in the University are taught. This has resulted in an increased importance being placed on individual work that the students do, but it should be always supervised and directed by the teacher. The supervision is generally carried out through three main ways: attended sessions, work in groups and that done at home. To cover all these new issues and needs many universities are applying a tool for e-Learning called Campus Virtual which is based on Moodle. This tool of exchanging information allows the teacher to offer resources of the subject that they teach and works as a communication path using messages and forums, as well as receiving reports done by the students, group assignments, etc. Nevertheless this tool can be limited in terms of flexibility and accessibility as the tutoring, in cases where a lot of self-learning is needed, requires communications to be fast, flexible and easy. In this scenario the social networks offer new possibilities.
We analyse the activity and satisfaction of various teaching groups on Facebook in different courses of the following degrees in the UCLM: Computer Science Engineering and Medicine. The results obtained during the first semester show a high level of participation and frequent access, as well as, good general acceptance and use of the information provided by both students and teachers. Our intention is to promote and extend the use of these social networks to groups with which we collaborate both at the University of Alicante and at the Advanced Technology, National Polytechnic Institute of Mexico, to be able to compare the results of different populations of students.
The use of student groups on Facebook represents a new way for the direct and rapid transfer of information that has been accepted and evaluated differently. The students are quite receptive of its use, as it is much more user-friendly than Moodle, which from the beginning students perceive as exclusively academic, associated with work and evaluation, and so it results less attractive to many of them and therefore is harder for the students to be an active part of. In fact for the teacher it is very complicated to create an active communication forum in Moodle, while in the groups created on Facebook the participation rate is quite high. This is due to the students being familiarized with these social networks and also with the enthusiasm of the teacher and the content of the information exchanged. However the use of Facebook by the teachers is not as common as desired, maybe because it means a duplication of effort and resources (putting the same information in two different places), which require more time being invested on the subject, even though it provides improved communications with the students. It is also worth mentioning that it can be a place to meet and exchange opinions and comments between the students and the faculty, enriching their self-learning, critical thinking, relationships, etc.

Keywords: Social/Media Networks, Facebook, ICT, Physics Education, Learning Process, Active Learning, University Physics

PS.11.06.d

Strand 3: Learning Physics Concepts

Parallel Session 11.06
Date & Time: 06.07.2012 / 09:00 - 10:30
Room: D404 (3rd Floor)

Measurement Engineering Student´s Retention of Basic Concepts in Electricity And Magnetism

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Both descriptive statistics and the classical test theory are theoretical frameworks useful in physics education research. We used these frameworks to measure student's retention of basic concepts in electricity and magnetism. The study population are Engineering students of University of Bogotá - Colombia.
These local statistical studies are needed to recognize general problems in physics learning in specific populations. For example, we do not know the initial conceptual state of our students when begin the course, it is unknown whether students have the same trends with regard to preconceptions, misconceptions and conceptual difficulties that the trends reported in international studies, and so on. This ignorance creates uncertainty for all stakeholders to improve the quality of teaching physics and teaching general science. Motivated by give solutions to the issues raised, we have taken the task of answering the question ¿What is the degree of retention of basic concepts of electromagnetism once students have completed the course for? The response has been addressed through the methodology pre / post test. We have used the tool: Brief Electricity and Magnetism Assessment, developed by Chabay and Sherwood in 1997. Data analysis is made through following factors: the concentration factor (Bao, Redish), average normalized gain factor (Hake) and the evolution factor (Hake).
We report preliminary results of the pre-test, such as no preconceptions about basic electromagnetic phenomena, such as no preconceptions about basic electromagnetic phenomena, absence of basic experiences with electromagnetic phenomena, etc. The post-test phase is being developed and is expected to bring the results of the analysis in full at the time of the congress.
The preliminary observation also points out the need for a rigorous test to assess the level or degree of sensory experiences the student has on basic electrical and magnetic phenomena.

Keywords: Physics Eduacation, electricity concepts, magnetism concepts

The list of the WCPE 2012 reviewers

The following experts have graciously served as reviewers for the World Conference on Physics Education 2012. The organizing committee wishes to thank them for all the hard work that they have done to make this conference a success.

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PS.06.01.d
Heft Paul
PS.10.07.d
Hellwig Julia
PS.09.07.a
Henrique Alexandre Bagdonas
PS.06.10.d
Heradio Rubén
PS.03.01.a
Hernández María Isabel
PS.10.04.a
Heron Paula
P1.G02.03
PS.02.10.S
PS.03.10.S
PS.04.05.S
Herrmann Friedrich
PS.10.05.d
PS.05.02.W
Herscovitz Victoria Elnecave
PS.06.10.c
Higuchi Katsuichi
P1.G05.02
Hill Matthew
PS.05.05.b
Hirvonen Pekka E.
PS.07.05.c
Hollan Jan
PS.03.07.W
Holmberg (née González Sampayo) Margarita
P2.G02.04
Hopf Martin
PS.11.05.d
Howard Robert
PS.07.10.c
Huang Xiang
PS.11.03.a
Huerta Virgen
PS.09.01.c
Hwang Fu Kwun
PS.10.06.c
P2.G01.02
PS.I.c
Hwang Seyoung
PS.04.01.S
Ibrahim Ahmed
PS.11.03.a
Indias Johanna Mae
PS.06.10.a
İnğeç Şebnem Kandil
PS.02.09.b
Ishak Mohd Zaki
PS.10.06.a
Ishii Kyoko
PS.05.09.a
PS.08.10.a
PS.08.09.W
Ishimoto Michi
P1.G05.03
Işık Hakan
P1.G03.06x
Ivanjek Lana
PS.07.02.b
PS.10.04.b
PS.10.07.a
Jarosz Jerzy
P2.G08.01x
Jedrkiewicz Ottavia
PS.11.04.b
Jelicic Katarina
PS.03.02.a
Jende Konrad
PS.05.10.a
PS.08.08.W
Jeong Jinsu
P2.G05.01

Jeppsson Fredrik
PS.09.02.c
Jeskova Zuzana
PS.07.04.c
PS.08.10.c
P2.G08.03
Ješková Zuzana
PS.01.03.W
João Herbert Alexandre
PS.07.10.b
Johnston Jennifer
PS.09.04.a
P2.G05.06
Jolly Pratibha
PS.04.03.S
Julio Josimeire Meneses
PS.06.04.c
Júlio Josimeire M
PS.04.04.S
Kahyaoglu Zeynep Tugba
PS.03.04.b
Kalman Calvin
PS.11.03.a
Kaltakci Derya
PS.07.06.b
Kanli Uygar
PS.09.03.b
Kapanadze Marika
PS.11.04.d
Kaper Wolter
PS.09.11.a
Karabay Ersoy
P1.G04.01x
Karaca Dilek
P1.G04.02
PS.05.09.b
Karam Ricardo
PS.07.01.d
P1.G05.09
Kartsonakis Manolis
PS.05.06.b
Kassebaum Thomas J.
P1.G01.03
Katramatou Mina
PS.10.07.c
Kawakatsu Hiroshi
PS.05.09.a
PS.08.09.W
Kawecka Elzbieta
P1.G01.05
PS.10.08.W
Kaymak Ercan
PS.06.06.d
Kazachkov Alexander
PS.10.03.b
Kazemi Kazem
PS.11.04.c
Kedzierska Ewa
PS.07.04.c
P1.G01.01, G01.05
PS.I.c
PS.01.03.W
PS.10.08.W
Kekule Martina
PS.08.04.b
Kermen Isabelle
PS.03.01.b
Kesonen Mikko
PS.07.05.c
Khalili Boroujeni Rouhollah
PS.08.04.c
Khaparde Rajesh Bhaskar
PS.08.03.b
P1.G03.04
Kiani Farahnaz
P1.G07.05x
P2.G02.06x
Kim Heui Baik
PS.04.01.S
Kim Jung Bok
P1.G02.02
P2.G07.02
Kim Jungbog
PS.06.04.a
Kim Youngmin
P2.G05.01
Kirbulut Zubeyde Demet
PS.10.06.d
Kires Marian
PS.07.04.c
PS.08.10.c
P2.G08.03
PS.01.03.W
Kirkwood Heath
PS.10.07.d
Kırmacı Hatice
P1.G07.04

Kırtak Vahide Nilay
PS.06.05.d
Kk Mashood
PS.02.05.a
Kneubil Fabiana Botelho
PS.09.01.b
Kobayashi Akizo
PS.09.06.c
PS.11.01.a
Kökcü Hanife
PS.10.06.b
Koltachykhina Oksana
P1.G07.06x
Kondrashova Diana
PS.03.09.W
Konstantinidou Aikaterini
PS.05.07.a
PS.09.02.d
Körndle Hermann
PS.08.06.a
Kortemeyer Gerd
P1.G05.11
Kosionidis Aristeidis
PS.02.02.a
Koudelkova Vera
PS.08.02.d
PS.09.04.d
Koupilova Zdenka
PS.08.04.a
Kranjc Tomaz
PS.03.11.b
PS.03.11.c
Kriek Jeanne
PS.07.06.a
Krijtenburg Lewerissa Kim
PS.07.10.d
Kuhn Jochen
PS.03.05.a
Kuo Yen Ruey
PS.05.05.d
Kurt Havva Sibel
PS.11.03.b
P1.G07.03
Kusak Radim
P1.G01.04
Kusar Tomaz
PS.03.03.b
Kuznetsov Sergey
PS.03.09.W
Kyriazis Athanasios
PS.02.09.d
Lacambra Wilfredo T.
PS.02.05.d
Lago Leonardo
PS.09.07.b
Lam Yen Ling
PS.10.04.c
Lambert Tom
PS.07.04.d
Lambourne Robert
PS.08.11.d
Lanciano Nicoletta
PS.09.01.a
P1.G04.03
Langlois Simon
PS.03.04.d
P1.G08.03
Lawrence Ian
PS.09.01.d
P2.G01.01
Laws Priscilla W
PS.11.01.d
Ledenmat Simon
PS.02.03.d
Lee Dong Uk
PS.05.03.d

Lee Dong Wook
PS.04.01.S

Lee Gyoungho
PS.11.03.a

Lee Irene Lay Koon
PS.10.04.c

Lee Jungsook
PS.06.04.a

Lee Siew Lin
PS.03.06.d
PS.06.04.b

Lee Sung Eun
PS.10.04.d

Lee Tat Leong
PS.02.09.a

Lehavi Yaron
P1.G02.03
P1.G03.02

Leite Cristina
PS.11.03.c
P1.G08.05

Lenci Lorenzo
PS.09.05.a

Leto Francesca
PS.05.04.a

Levrini Olivia
P2.G04.06

Leys Christophe
PS.05.03.a

Li Sissi
PS.08.05.b

Lim Ai Phing
PS.02.09.a

Lim Chew Ling
PS.02.09.a

Lim Ee Peow
PS.02.09.a

Lim Enu Hee
PS.04.01.S

Lim Eun Hee
PS.10.04.d

Lim Yang Teck Kenneth
PS.02.09.a

Lima Junior Paulo
PS.06.06.b
P1.G07.02

Linder Cedric
PS.05.05.a
PS.05.05.a
PS.05.05.c

Lindner Martin
PS.11.04.a
PS.01.03.W

Lindstrøm Christine
PS.02.05.c

Lisina Irina
PS.03.09.W

Liston Miriam
PS.09.04.a

Logiurato Fabrizio
PS.02.03.c
P2.G03.05

Logman Paul
PS.09.11.a

Lombardi Sara
P2.G02.03

Lopes Dos Santos João M. B.
PS.07.08.W

Lopez Ramon E
PS.09.11.c

Lopez Rios Sonia Janeth
PS.05.01.c

Ludwig Tobias
P2.G02.08

Lustig Frantisek
P2.G03.04

Lye Sze Yee
PS.02.09.a

Machado Vitor Fabricio
PS.03.05.b

Macho Stadler Erica
P1.G05.05
P1.G05.06

Macisaac Dan
P2.G06.05
PS.07.09.W

Madani Laya
PS.02.03.d

Magnoler Patrizia
P2.G04.06

Magon Juss Kaur
PS.11.03.a

Maio Amelia
PS.05.10.c

Maisch Clément
PS.03.01.b

Mala Zuzana
P1.G05.07

Maley Tim
PS.05.03.b

Malo Catherine
P1.G08.03

Mandikova Dana
PS.05.04.b

Mann Llewellyn
PS.02.02.d

Marchi Fernanda
P1.G08.05

Marco Giliberti
PS.05.03.c

Marco Stellato
PS.05.03.c

Mariadi Giri Cahyono
P2.G04.03

Mariani Cristina
PS.08.06.d

Mariotti Emilio
PS.02.09.c
P2.G06.08

Mariotti Maria Alessandra
PS.02.09.c

Marquez Marco Antonio
P2.G03.01

Marquez Rivera Ronald Gilberto
PS.05.01.c

Martin Hopf
PS.06.02.a

Martín Rodríguez Ernesto
PS.03.02.b
PS.06.07.W

Martinez Calros Alberto
PS.10.02.d

Mason Bruce
PS.11.02.c

Mathelitsch Leopold
PS.11.02.c

Mathis Kristian
P2.G04.05

Matloob Haghanikar Mojgan
P2.G05.04

Matlou Daisy
PS.07.10.a

Mattos Cristiano
PS.09.07.b

Mattos Cristiano Rodrigues
PS.07.03.b

Maximo Pereira Marta
PS.10.02.a

Mazzolini Alex
PS.04.03.S

Mazzolini Alexander Peter
PS.02.02.d

McCauley Thomas
PS.08.02.c

Mcclelland George
PS.09.04.a

Mcdermott Lillian
PS.10.04.b

Mcdermott Lillian C
PS.02.10.S
PS.03.10.S
PS.04.05.S

Mckean Michael
P2.G08.06

Mcloughlin Eilish
PS.07.04.c
PS.01.03.W

Medina Márcio Nasser
PS.05.10.d
P2.G04.04

Mejias Andres
P2.G03.01

Mendes Amanda
PS.03.05.c

Méndez Néstor Fernando
P1.G05.01x
Mercan Fatih Çağlayan
PS.10.07.b
Michelini Marisa
P1.G02.03,
P1.G04.06,
P2.G04.06,
P2.G05.05
Milér Tomáš
PS.03.07.W
Milin Sipus Zeljka
PS.07.02.b
Milner Bolotin Marina
PS.11.03.a
Mineo Sperandeo Rosa Maria
P2.G04.06
Miron Jean Pierre
P1.G08.03
Mirza Arshad M.
PS.07.03.d
Mirzaee Rafea Mehri
PS.06.03.W
Mirzoyan Julietta
PS.09.03.c
Mocerino Mauro
PS.09.03.a
Mohd Noor Soleh
P2.G08.07
Montalbano Vera
PS.02.09.c
P2.G06.08
P2.G07.03
Mora Cesar
PS.11.06.a
PS.11.06.c
P2.G05.07
Mora César Eduardo
PS.11.06.d
Mora Ley César Eduardo
PS.09.04.b
Moratalla Gonzalo
PS.11.06.a
Moreira Marco Antonio
PS.06.10.c
P1.G02.05
Mori Masazumi
P1.G01.06
Moro José Tullio
P1.G02.05
Mossenta Alessandra
PS.07.03.c
P2.G05.05
Mota Ana Rita Lopes
PS.07.08.W
Mota Fernando
PS.05.10.c
Mueller Rainer
PS.03.02.d
Müller Andreas
PS.03.05.a
Murphy Sytil
PS.06.02.d
Mutimucuio Inocente
P1.G08.02x
Mzoughi Taha
PS.03.01.d
Naidoo Deena
PS.07.10.a
PS.08.03.c
Najera Alberto
PS.11.06.a
PS.11.06.c
Narciss Susanne
PS.08.06.a
Nemeth Melissa M
PS.08.04.d
Neumann Guillermo
P1.G01.02
Neumann Susanne
PS.06.02.a
Neves Maria C.
PS.05.01.d
Neves Rui Gomes
PS.05.01.d
PS.09.08.W
Ng Soo Kok
PS.02.09.a
Nicolau Jorge
PS.06.10.d
Nieminen Timo A.
PS.11.05.b
Nitta Hideo
PS.09.02.b
Nordine Meloua
P2.G01.05x
Nouri Noushin
PS.05.09.d
PS.10.01.b
Novakova Danuse
P1.G05.07
Nwosu Victoria
PS.08.05.b
O`donoghue John
PS.09.04.a
O`meara Niamh
PS.09.04.a
Obadovic Dusanka Z.
P1.G02.07x
Oçak Mehmet Akif
PS.02.09.b
Ogan Bekiroğlu Feral
PS.06.06.d
PS.09.06.b
PS.10.06.b
Ogborn Jon
PS03
Ohno Eizo
P1.G02.06
PS.04.01.S
Okiharu Fumiko
PS.05.09.a
PS.09.06.c
PS.11.01.a
PS.08.09.W
Oktay Özlem
PS.06.06.a
Oliveira Leandro
PS.06.10.d
Onderova Ludmila
P2.G08.03
Ong Chee Wah
PS.02.09.a
Ong Matthew
PS.02.09.a
Onishi Haruka
PS.05.09.a
PS.08.09.W
Onofre Antonio
PS.05.10.c
Organista José Orlando
PS.11.06.d
Orozco Susana
PS.09.01.c
Ortega Alexander
PS.10.02.d
Ortega Medina Alexander
PS.08.02.b
Ortiz Maria De Los Angeles
PS.09.01.c
Osorio Quiroga Dairo
PS.05.01.c
Oss Stefano
P1.G03.07x
P2.G04.06
Ostermann Fernanda
PS.05.07.c
PS.06.06.b
Otero María Rita
PS.06.02.b
Ottaviani Giampiero
P2.G04.06
Oviedo Roa Juan Pablo
PS.05.01.c
Özcan Füsun Ebru
P1.G07.04
Özcan Özgür
P1.G06.01
Özdemir Ömer Faruk
PS.10.02.b
Ozulku Elif
P1.G05.08
Panta Priscila Chaves
P1.G07.02
Pantoja Glauco Cohen
PS.06.10.c

Parisoto Mara Fernanda
P1.G02.05
Park Jee Young
PS.04.01.S
Park Jeongwoo
PS.07.04.a
Park Jongseok
P2.G05.01
Park Jongwon
P2.G05.01
Park Youngshin
P2.G05.01
Parra Michael Alexis
PS.05.01.c
Pastor Junior Américo de Araújo
P1.G07.01
Patterson Scott
PS.10.07.d
Paulins Paulis
PS.01.01.W
Pavani Daniela Borges
P1.G07.02
Pavani Fabiane Borges
P1.G07.02
Pavlin Jerneja
PS.07.05.b
P1.G03.03
PS.06.09.W
Pawl Andrew
P1.G05.11
Pecar Maja
PS.07.05.a
P1.G05.10
PS.06.09.W
Peeters Wim
P1.G08.04
Peralta Luis
PS.05.10.c
Pereira Alexsandro Pereira De
PS.05.07.c
Pereira Ana
PS.05.10.c
Pereira Marcus Vinicius
P1.G07.01
Pereira Mario
PS.05.10.c
Pereira Vanessa Sanches
PS.09.01.b
Peressi Maria
P2.G04.06
Pérez Gabriela
P2.G08.02
Persano Adorno Dominique
PS.09.05.b
Pesa Marta Azucena
P2.G02.07
P2.G04.02
Phage Itumeleng
PS.03.04.c
Philippe Ageorges
PS.02.06.S
Philippe Colin
P1.G08.07
Pieters Maarten
PS.II.a
Pietrocola Mauricio
PS.03.05.d
PS.05.07.d
PS.06.10.d
Pietrocola Maurício
P1.G05.09
Pilaka Ramani V
PS.06.06.c
Pinheiro Nathan Carvalho
PS.10.05.c
Pintó Roser
PS.10.04.a
Pitts Marina
PS.05.04.d
Pizzolato Nicola
PS.09.05.b
Planinic Maja
PS.03.02.a
PS.07.02.b
PS.10.04.b
PS.10.07.a
Planinsic Gorazd
PS.03.02.a
PS.03.03.c
PS.05.01.a
PS.10.02.c
PS.10.09.W
Pohlig Michael
PS.06.05.b
PS.10.05.d
PS.05.02.W
Pol Henk
PS.07.10.d
PS.06.08.W
Politis Yurgos
PS.03.06.b
Porri Antonella
PS.02.09.c
Pospiech Gesche
PS.07.01.d
PS.08.06.a
Potting Robertus
PS.05.10.c
Pozo Juan Ignacio
P2.G04.02
Price Edward
PS.10.07.d
Priemer Burkhard
PS.09.07.a
P2.G02.08
Pritchard David
P1.G05.11
Psycharis Sarantos
PS.02.09.d
Pugliese Emanuele
P1.G04.04x
P2.G05.05
Qamar Anisa
PS.07.03.d
Racz Ervin
PS.09.11.b
Ramaila Sam
PS.09.03.d
Ramanathan Subramaniam
PS.06.04.b
Ramírez Díaz Mario Humberto
P2.G06.01x
Ramnarain Umesh Dewnarain
PS.09.03.d
Ramsey Gordon P
PS.08.04.d
Rancic Ivana
P1.G02.07x
Rankhumise Mmushetji Petrus
0482
Rayner Anton
PS.05.06.c
Rayyan Saif
P1.G05.11
Razpet Nada
PS.03.11.b
PS.03.11.c
Redfors Andreas
PS.05.05.c
Redish Edward (Joe) F
PS.04.04.S
Redish Edward F. (Joe)
PS.05.07.b
PS01
Reichl Jaroslav
PS.08.04.a
Rezende Filho Luiz Augusto Coimbra de
P1.G07.01
Ribeiro Anderson
P2.G04.04
Ricchi Ilaria
PS.05.06.d
Rihtarsic David
PS.03.03.b
P2.G08.04
Rinaudo Giuseppina
P2.G04.06
Ríos Sonia López
P2.G06.03
Roach John Şefik
PS.02.03.a
P2.G03.02

Rogozin Konstantin
PS.07.02.c
PS.03.09.W
Rojas Garcia Angel Antonio
PS.05.01.c
Roosta Jamshid
PS.11.04.c
Rossi Mauro
PS.02.03.c
P1.G03.07x
Rossi Sabrina
PS.09.01.a
P1.G04.03
Rotter Milos
P2.G03.06
Rovšek Barbara
PS.08.01.c
Ruddock Ivan S.
PS.03.03.d
Rufini Sueli Édi
P2.G06.07x
Ryoo Eunhee
PS.06.04.a
Sá Cristina Maria
P2.G08.05x
Sá Marta Vasconcelos
PS.08.06.c
Sabatka Zdenek
PS.08.02.d
PS.09.04.d
Saberi Maryam
P2.G02.05
Sadaghiani Homeyra R
PS.08.10.d
Saddul Hauzaree Sarojiny
PS.09.06.d
P1.G08.01
Sadrolashrafi Masood
PS.05.04.c
PS.10.01.d
PS.06.03.W
Salinas Castellanos Abraham
PS.10.03.b
Salszirnis Andrejs
PS.01.01.W
Sánchez José
PS.03.01.a
Sánchez Juan Pedro
PS.03.01.a
Sánchez Rubén
P2.G05.07
Sánchez Guzmán Daniel
P2.G05.07
Santi Lorenzo
PS.11.02.a
P2.G04.06
P2.G05.05
Santi Lorenzo Gianni
P1.G04.04x
Santos Itamar
PS.06.10.d
Santos Joao
PS.05.10.c
Santos Lucília Maria Pessoa Tavares Dos
P2.G08.05x
Sapia P.
PS.06.05.a
Sari Musa
PS.11.03.b
Sarı Musa
P1.G07.03
Sasseron Lucia
PS.10.03.d
Sasseron Lucia Helena
PS.03.05.b
PS.03.05.c
PS.07.01.a
P1.G02.01
Sassi Elena
PS.05.06.d
P2.G02.03
PS.09.10.W
PS.10.09.W
WG-II.01
Sato Minoru
PS.10.01.c
Savino Giovanni
PS.07.01.b
Sawtelle Vashti
PS.04.04.S
Scarinci Anne L
PS.11.01.b
Schiltz Guillaume
P1.G01.07
Schmitt Bill
PS.03.06.c
Schmoranzer David
P2.G03.06
Scholtz Martin
P1.G05.07
Schönborn Konrad
P1.G04.05
Schuster David
PS.05.06.a
Schweickert Frank F.
P2.G01.04
Seaton Daniel
P1.G05.11
Segarra Pilar
PS.09.01.c
P1.G01.02
Segarra Alberú Pilar
PS.07.06.c
Segedinac Mirjana
P1.G02.07x
Seixas Joao
PS.05.10.c
Seker Hayati
PS.11.03.d
Selau Felipe
P1.G07.02
Şen Ahmet Ilhan
PS.02.09.b
Seydim Arzu Calık
P1.G07.04
Seyed Fadaei Azita
PS.09.04.b
Shaffer Peter
PS.10.04.b
Shah Syed Naseem Hussain
PS.08.11.a
Sharma Manjula
PS.04.03.S
Sharma Manjula Devi
PS.05.05.b
PS.06.05.c
Sharma Sapna
PS.06.10.b
Sheikh Abdullah Siti Hendon
PS.02.02.b
P2.G08.07
Shellard Ronald
PS.10.03.a
Shu Ying Shao
PS.10.06.c
Siddiqui Salim
PS.05.05.d
PS.08.03.d
Singh Vijay A
PS.02.05.a
Siqueira Maxwell
PS.03.05.d
Slisko Josip
PS.08.05.d
PS.10.02.c
Smaldone Luigi A.
PS.05.06.d
Smeets Pieter
PS.10.10.W
Snetinova Marie
PS.08.04.a
Soares Sandra
PS.05.10.c
Sokolowska Dagmara
PS.02.04.b
P1.G08.04
Soltani Kafrani Asghar
PS.11.04.c
Sonneveld Wim
PS.06.08.W
Sotiriou Sofoklis
PS.10.03.c
Southam Daniel
PS.08.03.d
PS.09.03.a

Southey Philip
PS.08.05.b
Sperandeo Mineo Rosa Maria
PS.09.05.b
PS.09.07.c
Sri Challapalli
P2.G05.05
Srinivas Sudha
PS.02.03.b
Stari Cecilia
PS.09.05.a
PS.09.05.c
P2.G08.02
Stavrou Dimitrios
PS.03.11.d
Stefanel Alberto
PS.07.03.c
PS.08.11.c
PS.11.02.a
P1.G02.03,
P2.G04.06,
P2.G05.05
Stella Rosa
P2.G04.06
Stoll Will
PS.05.03.b
Storr Mick
PS.10.03.a
Subramaniam Ramanathan
PS.03.06.d
Susac Ana
PS.07.02.b
PS.10.07.a
Susanna Occhipinti
PS.03.06.a
Susman Katarina
PS.03.03.b
P2.G08.04
PS.06.09.W
Suzuki Toru
PS.06.04.d
Svoboda Julia
PS.04.04.S
Svobodova Jindriska
PS.03.07.W
Szczygielska Aneta
P2.G08.01x
Tagiku Armando
PS.06.10.d
Takahashi Naoshi
P1.G01.06
Talero Paco Hernando
PS.11.06.d
Tamburini Laura
PS.07.03.c
Tanemura Masako
PS.05.09.a
P1.G07.07
PS.08.09.W
Taniguchi Masa Aki
PS.02.05.b
Taniguchi Masaaki
PS.05.09.a
PS.08.09.W
Taşar Mehmet Fatih
PS.02.09.b
PS.06.01.b
PS.08.10.b
P2.G01.06
Tassere Zimba
P1.G08.03
Tavares Luciani Bueno
PS.07.03.b
Taylor Julian
PS.08.05.b
Teese Robert B
PS.11.01.d
Teodorescu Raluca
P1.G05.11
Teodoro Vítor Duarte
PS.05.01.d
PS.09.08.W
Testa Italo
P2.G02.03
Thornton Ronald K.
WG-I.01
Thurlings Anneke
PS.10.10.W
Timur Betül
PS.02.09.b
PS.06.01.b
PS.08.10.b
P2.G01.06
Tinker Robert F.
PS02
Titulaer Urbaan M.
PS.09.06.a
Tra Do Huong
P2.G06.04x
Treagust David
PS.05.05.d
Triki Meriam
P1.G08.07
Trna Josef
PS.02.04.d
Tsamis Vagelis
PS.10.03.c
Tsourlidaki Eleftheria
PS.10.03.c
Turpen Chandra A
PS.04.04.S
Tzani Maria
PS.02.02.a
Uhden Olaf
PS.07.01.d
Unal Coban Gul
PS.11.03.a
Urban Woldron Hildegard
PS.11.05.a
P1.G01.05
P1.G06.03
PS.10.08.W
Uşak Muhammet
PS.02.09.b
Valenta Veronika
P1.G06.03
Van Kampen Paul
PS.08.02.a
Vanraes Patrick
PS.05.03.a
Vargas Marco
P1.G07.02
Vaupotic Natasa
PS.07.05.b
P1.G03.03
Vaz Arnaldo De Moura
PS.06.04.c
Vaz Arnaldo M
PS.04.04.S
Veit Eliane Angela
P2.G06.02
P2.G06.03
Veloso Filipe
PS.05.10.c
Veloso Joao
PS.05.10.c
Venugopal Vinay
PS.08.11.b
Venville Grady
PS.05.04.d
Vercellati Stefano
PS.03.02.c
PS.05.10.b
P1.G04.06
P2.G05.05
Verdoolaege Geert
PS.05.03.a
Verenkar Vijaykumar C
P2.G03.03x
PS.08.07.W
Vesali Mansour
PS.05.09.d
PS.10.01.b
P2.G02.05
PS.02.08.W
Vicentini Helio
PS.06.10.d
Viennot Laurence
PS.09.10.W
PS.10.09.W
Vilaró Mariana
P2.G08.02
Vitu Tomas
P1.G05.07
Vlahakis George N
PS.09.02.d

Vogt Patrik
PS.03.05.a
Wagner Clemens
PS.09.02.a
Walet Niels
PS.08.05.c
Wallace Marsali Beth
PS.11.01.c
Wallner Benjamin
P2.G02.02
Wang Xihui
PS.11.03.a
Ward Jo
PS.08.03.d
Watanabe Graciella
PS.05.07.d
PS.06.10.d
Wattanakasiwich Pornrat
PS04
Webb David
PS.03.04.a
Weber Jeremias
PS.06.01.a
Wee Loo Kang Lawrence
PS.02.09.a
Wegener Margaret
PS.10.05.b
Widuch Stefania
P2.G08.01x
Willis Maxine C
PS.11.01.d
Wirjawan Johannes V.d.
PS.06.02.d
Wojtyna Jodko Alicja
P2.G07.06
Won Mihye
PS.05.05.d
Xie Charles
P1.G04.05
Xu Weiming
PS.02.09.a
Yamada Yoshihide
PS.08.10.a
Yasuda Jun Ichiro
PS.02.05.b
Yasuda Junichiro
PS.05.09.a
PS.08.09.W
Yeo Shelley
PS.09.03.a
Yeo Wee Leng Joshua
PS.02.09.a
Yerdelen Damar Sevda
PS.02.04.a
Yıldırım Ufuk
P1.G03.01
Yokoe Mika
PS.05.09.a
PS.08.09.W
Yoo Junehee
PS.05.03.d
PS.07.04.a
PS.10.04.d
PS.04.01.S
Yun Sun Mi
PS.04.01.S
Yuste Manuel
PS.03.01.a
Yusuf Mehmet
P1.G04.01x
Zadnik Marjan
PS.05.04.d
PS.05.05.d
PS.08.03.d
PS.09.03.a
Zak Vojtech
PS.08.04.b
P2.G03.06
Zanardi Danilo Claro
PS.09.01.b
Zavala Genaro
PS.07.02.d
PS.11.05.c
Zdrazilova Zuzana
P2.G04.05
Zettili Nouredine
PS.08.06.b
P2.G05.03
Ziherl Sasa
PS.07.05.b
P1.G03.03
PS.06.09.W
Zollman Dean A
PS.06.02.d
P2.G05.04
PS.04.04.S
Zuccarini Giacomo
PS.08.11.c
Zuza Kristina
PS.07.05.d
PS.08.02.a

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