Using Physlet Based Peer Instruction for Regents Physics Review

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Abstract

I describe instructional experiments helping my Regents Physics students review for their NYSED Regents Physics exams. My forty-three students were divided into groups and assigned sets of NYS Regents content standards. Each group of students was required to find a web-based computer simulation that demonstrated the principles of the assigned content standards. Students then used their simulation as the center of a peer-teaching session. Justification for the project is given based on references from the literature that support both peer teaching and the use of web-based computer simulations in the classroom. The observed positive results of the project were both affective and motivational.

Introduction

Computer simulation is a powerful tool at the disposal of education and science technology. Years ago, programs like Interactive PhysicsTM gave teachers the ability to demonstrate interactions that would have been otherwise difficult to create in the classroom. With the advance of the Internet and the widespread use of applets (small application or "appl"+ette) that run within the control of a web browser (www.merriam-webster.com, 2008), many authors have written and shared simulations across the physics education community. Christian and Belloni have dubbed these applet based physics simulations, *Physlets* (2001). In an effort to use these resources effectively, I have developed a project that asks students to use Physlets as a peer-instruction tool.

Justification

Peer instruction techniques have been well documented within pedagogical literature and many of these studies suggest that peer instruction is an effective technique in the classroom. Supporting examples include the correlation of peer instruction with social and academic gains for high achieving students in science classes (Johnson, Johnson, and Taylor, 1994) and correlations with overall achievement gains in Biology (Tessier, 2004) and Physics classrooms (Crouch and Mazur, 2001). A wealth of support for the practice can be found as early as the 1970's when Menall (1975) noted that peer instruction has been deemed effective in dozens of studies that have focused on different subject matter and methods.

Because they are a product of the file sharing potential of the Internet, physlets are a relatively recent phenomenon, but their use in the classroom has also been documented. Christian and Belloni (2001) have drawn on years of experience both to present new Physlets and to offer effective techniques by which to use them in the classroom, including having physics majors code the programs themselves. Particularly insightful research was conducted by Lee, Nicoll, and Brooks (2004) suggesting that students using Physlets in learning activities gained a better understanding of physics, particularly if the "cognitive load" was not set unrealistically high.

My Project

In a classroom where Physlets are used in lectures and demonstrations, students can see computer simulations used as effective instructional tools. This project drew upon the teacher's example to require that students create a short review lesson on one concept that was presented using a Physlet as the center of the lesson. The project was divided into six steps, each with well-defined parameters stated in a grading rubric.

Step #1: Grouping and Assignment

The students were divided into groups. Each group was assigned a set of content standards that could all be represented in the context of a single Physlet. The sets included the verbatim text of both the "Process Skills" and "Major Understandings" from the New York State Physical Setting: Physics; Core Curriculum (NYSED, 2008). Some examples of the content sets appear in Appendix A, and the entire list of content sets can be accessed at http://physicsed.buffalostate.edu/pubs/PHY690/Sears2007PeerTchgPhyslets/. At this time the students also received a project description (Appendix B) and a correlated grading rubric (Appendix C). The rubric emphasized connecting the content set to a physical context, which could then be demonstrated with the physlet and explained effectively.

Step #2: Connecting Physics to a Physical Context

The students were asked to consider a specific contextual event wherein the physical rules expressed in their Content Set could be seen to act. Each group produced a clear, well-labeled diagram of the contextual event. All relative quantities, vectors or not, were to be represented on the diagram. For extra credit, at this point, I required that the diagrams include physically reasonable numbers for each quantity.

Step #3: Finding a Physlet

The students had to find one or more Physlets that matched their Content Set and contextual diagrams. Before I approved their choices they wrote a description of the Physlet that focused on its relevance to the content standards they had to explain. I prompted for specific detail on quantitative and qualitative statements in the grading rubric.

Step #4: The Lesson Plan

The students worked together to create a written lesson plan for their peer instruction. The rubric suggested that the lesson plan include four parts. Part one included a statement of the content standards the students had been assigned and class questioning to solicit prior knowledge, followed by direct explanation to make clear to the audience the vocabulary required to effectively discuss the relationships involved in those standards. Part two of the lesson involved using the Physlet to show the relationships called out by the standards, both qualitatively and quantitatively, by soliciting predictions and then running the Physlet. Part three was the presentation of an actual Regents question and an explicit explanation of how the information given in the problem was connected to the standards. Finally, in part four of the presentation, the class solved the problem on small whiteboards, after which the presenting group was to explain the solution using the whiteboards created by the class.

Step #5: The Presentation
The students presented their lessons to the class. Groups were encouraged to use PowerPoint ™ so that the Physlet was smoothly integrated into the lesson and to use good public speaking methods, as indicated on the rubric.

Step #6: Reflection
Each participant wrote a simple reflection on his or her experience. Although they were encouraged to share their thoughts about the project in general, there were three points the students were required to include.

- What went well and how did you know?
- What went poorly and how could you have improved it?
- What did you understand better when the presentation was over?

Results

Judging by the students' enthusiasm and the quality of their presentations, the peer instruction review project was a great success in my classroom. I observed a variety of effects in my students, some of which related to their understanding of the Regents Content Standards, and others that had more to do with their skills as students and learners. In addition to this, exciting affective results stayed with the students long after the project was completed.

As for basic cognitive gains, the obvious benefit for my students was their ability to explain their assigned set of content standards to the class. The requirement that all students take part in the presentation resulted in groups of students who had helped each other to achieve strong conceptual understandings. The students' ability to explain the Physlets' controls and actions in the context of content standards suggested that they had achieved understanding on the level of application or analysis.

My students demonstrated other skills during this project that were impressive and worthy of mention. In the Step #2 of the project they created accurate, creative, and well-drawn diagrams that married attention to detail with creative thought. The ability to create PowerPoint™ presentations that were

attractive, fluid, and complete was on a par with both my own, and that of many professional presenters. The students worked hard to create presentations, both the digital slides and their verbal contributions that they could be proud of. In addition to PowerPoint™ and presentation skills, the students demonstrated excellent teamwork as they divided up, and then completed, tasks required to finish the project. This project provided a venue for students to unexpectedly impress the instructor.

The motivational effects of this review project were evident from the first day in the classroom. From the moment the students began creating diagrams for their assigned content standards, there was a great deal of positive energy in the room. My students are used to explaining solutions to physics problems to the entire class. This project utilized the students' familiarity with class presentation and a comfortable, structured format, resulting in a strong enthusiasm for likely public success. Evidence for this enthusiasm could be seen on their faces and in their high degree of engagement.

Organizing and managing this project in class took a good deal of instructor time and effort and it's easier to do a traditional rapid fire test question review that might cover the same material in less time. Review work comes at a time when the students are at their most distracted and restless, however, this project motivated them to work for their own understanding. The fact that my students performed so well at such a difficult time of the year is the most compelling reason I have to recommend this project to others who are fans of Physlets in the classroom.

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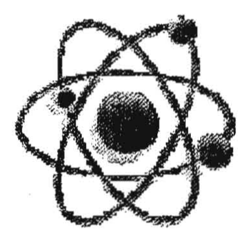

Appendix A: NYSED Physics Content Standard Review Sets (Partial List)
(Standards taken from: *http://www.emsc.nysed.gov*)

Electric and Magnetic Phenomena

Set #1
4.1b Energy may be converted among mechanical, electromagnetic, nuclear, and thermal forms.
4.1p Electrical power* and energy* can be determined for electric circuits.
4.1.vi. Recognize and describe conversions among different forms of energy in real or hypothetical devices such as a motor, a generator, a photocell, and a battery

Set #2
4.1n A circuit is a closed path in which a current* can exist. (Note: Use conventional current.) *4.1.viii.* Measure current and voltage in a circuit
4.1.xiii. Draw and interpret circuit diagrams which include voltmeters and ammeters

Set #3
4.1l All materials display a range of conductivity. At constant temperature, common metallic conductors obey Ohm's Law*.
4.1.ix. Use measurements to determine the resistance of a circuit element
4.1.x. Interpret graphs of voltage versus current

Set #4
4.1m The factors affecting resistance in a conductor are length, cross-sectional area, temperature, and resistivity.*
4.1.xi. Measure and compare the resistance of conductors of various lengths and cross-sectional areas

Set #5
4.1o Circuit components may be connected in series* or in parallel*. Schematic diagrams are used to represent circuits and circuit elements.
4.1.xii. Construct simple series and parallel circuits
4.1.xiv. Predict the behavior of lightbulbs in series and parallel circuits

Set #6
4.1k(a) Moving electric charges produce magnetic fields.
4.1.xv. Map the magnetic field of a permanent magnet, indicating the direction of the field between the N (north-seeking) and S (south-seeking) pole

Appendix B (assignment description student handout)

Physlet Review

Objective
Examine a group of physics ideas (known as "content standards") and lead the class in a short review session of those ideas with the aid of on-line animations like the ones Mr. Sears has used during the year.

Process

Step #1
Find 1 or 2 partners (+2 bonus points for working in pairs)
Get a Group # and set of Content Standards from Mr. Sears

Step #2
Pick a contextual event that demonstrates the physics in your Content Set
Draw diagrams to show the concepts in context

Step #3
Find a Physlet
Describe the Physlet in writing
Write an explanation of the connection between the Physlet and the content standards

Step #4
Make a step-by-step lesson plan for each of 4 sections:
1. Introduction (what are your standards)
2. Physlet presentation (What do the standards mean)
3. Typical question (Present an actual regents question)
4. White boarding
   (Discuss solution after class attempts to solve question)

Plans for parts 1 & 2 should include at least 4 questions to ask the class during the lesson.
A complete solution should be prepared for parts 3&4, even if the example is multiple choice.

Step #5
Present the lesson to the class

Step #6
Write a reflection of the experience including:
What went well during the lesson and how do you know?
What went poorly during the lesson and how you could make it better?
What you understood better after the process?

Appendix C (Grading Rubric)

Name ____________________

____

____

Step #1
- O Find group (____)
- O Get set of Content Standards

Step #2
- Ox2 On time (due:________________)
- O Appropriate Context
- ODiagram
  - O Neat and well drawn O Labels on objects O Title and key
  - O Labels and vector arrows on any relevant measurements

Step #3
- Ox2 On Time (due:________________)
- O URL and name of *appropriate* Physlet
- O Written Description
  - O Visual appearance OAnimation O Variables (quantities)
  - O User Controls O What physical actions are represented
  - O What do the standards say about those actions qualitatively?
  - O What do the standards say about the quantities displayed?

Step #4
- Ox2 On Time (due:________________)
- O 4 part Lesson Plan

Pt1	O ID of Standards	O Define terms	O Questions for class
Pt2	O Explain Concept	O Explain Physlet	O Adjust controls/Ask for predictions
	O Run Physlet/Discuss results		O Present alternative context
Pt3	O Appropriate regents question		O Explain connection to standards
Pt4	OComplete/accurate solution		O Closing

Step #5
- Ox2 On Time (due:________________)
- O Face class O Speak clearly O All partners speak O Integrate Physlet smoothly
- O Pt1 OPt2 OPt3 OPt4 O Stay focused

Step #6 (One reflection from each team member) (due:________________)

____________	____________	____________
O On Time	O On Time	O On Time
OWhat went well	OWhat went well	OWhat went well
OWhat went poorly	OWhat went poorly	OWhat went poorly
O What you learned	O What you learned	O What you learned

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Patrick Sears *grew up in a small town outside of Syracuse, NY where his experiences with motorcycles sailboats, tractors and cars left him with an interest in the physical world. He followed this interest to SUNY Binghamton where his received a Bachelors degree in Physics. He spent time on the road as a stage hand for Reba McIntyre and worked for production companies in five states. He began teaching physics in 2000 in Oakland, CA, where he received his first teaching credential. In 2005 Patrick moved to Buffalo, NY and began teaching in the suburbs and working on a Masters degree in Physics Education, which culminated in this publication. He is currently employed full-time as an engineer and part time as a physics teacher. He can be reached at:* crak2o@yahoo.com