Altering the Misinterpretations of Newton's Third Law Through Inquiry and Hands On Discovery

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Abstract:

This paper shows how seven *special students* ~~were reformed in~~ their thinking about Newtonian force concepts. The ~~students~~ were tested for understanding, and through inquiry based lessons along with useful activities as well as animations and visual aids the students' mis-conceptions were re-formulated into a deeper cognitive understanding of Newtonian force concepts. The results of the lessons were evaluated six months later, to show the concepts were still clear to the students at a high enough understanding for them to be able to elaborate and use peer-teaching methods in the classroom.

Acknowledgements:

This manuscript was prepared as part of requirements for *PHY690: Master's Project* at SUNY Buffalo State College, under the direction of Dr. Dan MacIsaac, Prof. Joe Zawicki, and Dr. Dave Abbott. Thank you also to my peers in Physics Workshops and colleagues along the way that have helped me develop ~~such~~ a broad understanding of the pedagogy that is involved in the teaching of physics. And special thanks to Yianna Fantrazzo for listening to me read for so many years.

"Truth is ever to be found in the simplicity, and not the multiplicity and confusion of things." - Sir Isaac Newton

Avoid passive voice

Introduction

Reform in physics teaching is the result of many teaching techniques that are new to the classroom. Inquiry based learning is teaching by asking questions, in a Socratic manner where students are led to discover what they know about a given topic. The use of whiteboards and peer-teaching are also methods whose popularity in the classroom has grown over the last decade. Studies are leaning to a more student driven lesson rather than lecture and notes version of memorizing details.

Huh?

these claims need citations

With a wide variety of teaching resources, a teacher is able to reach a wide variety of students with just as varied a range in learning styles. The *lecture/note taking* classroom is too structured for the mentally immature *special students*. According to the American Association for the Advancement of Science (1989) students should be conceptualizing science in terms of connected and interrelated themes which are linked across disciplines.(McCarthy, 2004) The importance of relating the physical world to students' personal experience in showing the interconnection to real time can help promote scientific literacy across the board. In short, the teacher needs to find out what the student knows and teach accordingly. With the introduction of hands on learning and animation, even the most juvenile students can understand concepts relating to real world applications. Research states that activity based instruction may be more appropriate than the traditional textbook approach for students with unique learning needs (McCarthy,2004).

what is meant by this word?

I don't understand the point of this section

Literature: Using the New York State Education Department's website: http://www.emsc,nysed.gov/ciai/mst/pub/phycoresci.pdf , Teachers can find the New York State Physics Core Curriculum. Related to this concept Standard 1, Key Ideas 1, 2 and 3; Standard 4, Key Ideas 4 and 5 with performance indicators 4.1a,c,and d along with 5.1b-d,5.1q and r; Standard 6, Key idea 1.

Objects "having force" is its own misconception

Student Misconceptions about Newton's Third Law

- The students thought size was the determining factor. If an object is bigger it has more force.
- The students saw forces coming from all directions, even the force of air. This clause does not follow from the rest of the sentence
- The force of gravity was clearly a point of confusion for the students. They realized that gravity was a consideration but never really thought about it unless it was mentioned. Whenever the student's saw gravity as a choice in the answer, they automatically chose it because they think it is always present.

are these from the literature, or things you observed w/ your students? If it's the latter, it does not belong in the intro.

Procedure

The students were given a condensed version of the Force Concept Inventory (FCI) (D. Hestenes, 1992) to test their conceptual knowledge of Newtonian forces, (questions relating to Newton's Third Law). After which they were interviewed in a classroom setting as to their reasoning behind the answers they choose. After our discussions about their beliefs I knew they had to see the results of forces in action because they were still asking questions dealing with the size of the objects.

First, the students used the wall as a brace and held a bathroom scale up on the wall at chest height, to find the force of their push on the wall, and in doing so, the force of the wall back on them (pair forces) Here I introduced the picture of Pears' Forces'

I wanted to use activities because I believe that is how I learned. There was the activity where the students got into groups of three, and using the bathroom scales and the office chairs with wheels they were able to see with their own eyes about equal forces at work. The students would take turns pushing or sitting in the chairs and reading the scale. Using the learning cycle techniques (Lawson,1999) along with Bloom's Taxonomy (B, 1956) the students' seemed to respond very well to the lessons. The look in their eyes was priceless, the "A HA" moment when the scales would read the same number, splitting the force in half. (The use of spring scales and rubber bands can also be utilized here, with the same results. But the chairs in the hall are more fun, therefore the memory is worth the activity.)

The "learning cycle" technique used in reformed science education classrooms is paving the way to an exploratory way of teaching; where the teacher very gently leads the children through their discussions

in a Socratic manner. This takes practice and every time I teach a lesson I get better. The classroom discussion is student driven and the students get better the more this method is used as well. When using certain key phrases this teaches children how to think about the process of problem solving. For example, "how do you think that happened? Or, "why do you suppose that is?" Content knowledge is built and once the concept is understood, the students teach each other and in doing so retain the knowledge in a deeper sense because now they have said the words and understood them well enough to explain the concept to someone else.

Now that the concept is challenged, the science behind the theory can be explored. I use a web-site http://www.grc.nasa.gov/WWW/K-12/airplane/index.html to really get the visual learner. This site introduces arrows and the magnitude of balancing forces and it is easy for the students to maneuver around the site; keeping them busy answering questions about real life applications to force pairs.

Free body diagrams, are another tool used to show forces acting on an object. The *special students* had never up to this point seen a diagram of this nature. At first, the arrows came from all directions at random angles. The use of the web is invaluable when it comes to practice. The students can work at their own pace and get the correct response as well. Another site for practice with FBD is http://www.grc.nasa.gov/WWW/K-12/airplane/index.html ; this one is good to give them the vocabulary and have the students test their knowledge as well as allowing for more practice with FBD's.

How?

The students were assessed as to their retention of the knowledge they acquired, six months after the lessons and their scores showed 100% retention. They all understood the concepts and were able to explain FBD's using scientific literacy. Studies have found that most of the forgetting occurs very soon after learning takes place (Intelegen Inc., 1995) if the material is meaningful to the students and you have their undivided attention during acquisition, the students seem to remember better. I would also

I doubt it. This isn't true for any group of students. I've worked w/ ... Your evidence certainly does not support this grand claim

use key words such as "equal" and I taught the students to look for key words, as research shows recognition is easier than recall (Intelegen Inc., 1995)

I will conclude by saying, "the study on *seven special students* does not prove these lessons are fail-safe for all students, but it is definitely a place to start"

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