Measuring The Learning Effects of Inquiry-Based Teaching with Computer Simulations

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1 Purpose
Ample scientific research has been focused on the learning effects of computer simulations in science education. However, most research has ignored the pedagogical context in doing so (authors, 2012). The purpose of this study is to investigate different approaches to teaching with computer simulations, and in doing so, taking the pedagogical context into account.

2 Theoretical framework
The difference between the two simulation-supported teaching approaches that we investigated, is that in one of the conditions the teacher taught in a way that was prepared by the teacher himself/herself, and in the other condition the teacher taught with the same computer simulations following a Peer Instruction approach (Crouch, Watkins, Fagen, & Mazur, 2007).

3 Method
This experiment has been performed in the classes taught by three teachers. Each teacher taught physics to parallel classes, whereby each class was taught in a different way with computer simulations: in one of the classes Newtonian mechanics was taught in way that was prepared by the teacher, and in the other class a Peer Instruction approach was followed, supported by an electronic voting system. In both conditions teachers used the same computer simulations. The lesson series of both conditions were designed as follows: in the first lesson the students conducted a pretest, in the second and third lesson the experiment was conducted, in the fourth lesson the students performed a posttest, and in the fifth lesson—a one month later—a delayed posttest was conducted. At the pretest, the posttest, and the delayed posttest data was collected by having the students fill in the Force Concept Inventory, a questionnaire measuring conceptual insight in Newtonian mechanics (Hestenes, Wells, & Swackhamer, 1992). Learning effects were investigated by performing paired-samples t-tests.

4 Results
Paired-samples t-tests show that when teachers prepared the lessons themselves, scores on the FCI do not increase between the pretest (M = 12.24, SD = 4.01) and the posttest (M = 12.88, SD = 4.00); t(41) = -1.65, p = .11; or the pretest (M = 12.23, SD = 4.03) and the delayed posttest (M = 13.20, SD = 3.74); t(39) = -2.01, p = .05. However, in case teaching with computer simulations is supported by our Peer Instruction approach, FCI-scores increase between the pretest (M = 11.96, SD = 4.30) and the posttest (M = 13.93, SD = 4.49); t(56) = -4.28, p < .01; as well as between the pretest (M = 11.85, SD = 4.35) and the delayed posttest (M = 14.46, SD = 4.57); t(53) = -5.35, p < .01.
5 Scientific significance of the study

One of the conclusions in our review study of the literature was that ample research has been focused on the learning effects of computer simulations, but the effects of the surrounding pedagogical context has been mostly ignored. As this pedagogical context has received insufficient attention, the question of how one is supposed to teach with computer simulations remains unanswered. With the present study we specifically focus on this question by keeping the simulations and the teacher constant between conditions, and only varying the pedagogical approach.

6 References
--Authors (2012)

Integrating Project Method and Potentially Meaningful Teaching Units to facilitate meaningful learning of concepts of thermodynamics to undergraduate students in Engineering

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JUSTIFICATION: In Brazil, According Brandan (2009), there is a scarcity of professionals in the field of Engineering. While in countries like Japan there are 25 engineers for each 1000 people professionally active, in Brazil there are just six. This little interest might exist because the students perceive little or no relation between Physics and Engineering in their high school classrooms.

CONTEXT: This research was applied in two classes of the engineering, where was taught concepts of thermodynamics.

THEORETICAL FRAMEWORK: In our proposal we used the project method according to Carl Rogers (Rogers, 1977), consisting of 4 phases: Students 1) define project and learning objectives in a contract; 2) conduct project work; 3) self-evaluate their work and learning; 4) and finally present their work to peers.

RESEARCH QUESTIONS: this research was organized into three studies, in which the first one attempted to answer the following research questions: 1) How to integrate, in a didactical proposal, situations of physics applied to engineering, the Potentially Meaningful Teaching Units (PMTUs), and the Project Method so that this integration could work towards facilitating the meaningful learning of physics concepts? 2) What problem-situations that can help engineering students to give meaning to physics concepts of thermodynamics? 3) Can the students learning of concepts of physics, which may derive from the implementation of this proposal, be considered meaningful?

RESEARCH METHODOLOGY: qualitative and quantitative methods were triangulated, and research instruments were validated and tested for their reliability. The qualitative methodology chosen for this research was ethnographic (André, 2005), while the quantitative one was based on descriptive and inferential statistics (Dancey e Reidy, 2007). Data gathering used a quasi-experimental design for time equivalent samples (Campbell e Stanley, 1979). The data is analyzed based on Bloom’s Taxonomy of educational objectives (Krathwohl 2010) and the work of Bardin (2009).