DYNAMIC, INTERACTIVE SIMULATIONS FOR ENHANCING STUDENT LEARNING

Timothy J. McIntyre[a], Anthony P. Roberts[a], Margaret J. Wegener[a], Juan C. Ponce Campuzano[a], Elise P. Kenny[a], Kelly E. Matthews[b]

Presenting Author: M.J. Wegener (m.wegener@uq.edu.au)
[a]School of Mathematics and Physics, The University of Queensland, Brisbane, Queensland, 4072, Australia
[b]Institute for Teaching and Learning Innovation, The University of Queensland, Brisbane, Queensland, 4072, Australia

KEYWORDS: Active Learning, Simulations, Interaction

Background

Active learning strategies have been widely introduced as an improved way of assisting student learning. In the “Flipped Classroom” approach, formal lectures are replaced by interactive discussion sessions with content delivered to students beforehand, usually through the use of on-line videos. In physics classes at the University of Queensland, we have adopted the approach of Mazur (2004) where students are expected to prepare for lectures by completing a textbook pre-reading, and the interactive classes are facilitated using electronic feedback devices. This style of teaching has led to a demonstrated improvement in students’ ability to understand complex physical concepts (see Drinkwater et al, 2014).

An integral part of the success of this approach is that students commit to participating in the pre-class activities. Furthermore, these activities are usually passive (watching a video, reading text) and, even if students do study the material, they may only develop a limited understanding. We attempted to address this issue by introducing on-line modules, ``Five Minute Physics”, which incorporated text, images, video and simulations. We found a significant improvement in the proportion of students who completed the pre-reading (see McIntyre et al, 2015) when provided in this format. Our successes (and failures) in these activities have motivated us to further investigate this innovative approach to student learning.

Aims

We seek to develop, test and disseminate the use of simulations and associated teaching packages in helping students prepare for interactive lectures. We aim to do this across a number of courses in physics and mathematics, evaluating the usefulness and impact of the approach in each case.

Description of intervention

We first investigated possible platforms for delivering the simulations and decided to use the Javascript programming language which was used in the Five Minute Physics Approach and the GeoGebra language which is targeted towards mathematics (Hohenwarter and Preiner, 2007).

For each course involved in the project, we identified topic areas where simulations could be used to aid learning. For some topic areas, simulations already existed and were used directly for the project. There are also simulations available across the internet, a notable high-quality set being the PhET simulations (Wieman et al, 2008) which cover a wide range of physics and mathematics concepts. We also developed new simulations as needed.

Along with each simulation we developed a teaching package which described the simulation and suggested concepts to investigate. In most cases we also incorporated the simulation into an assignment that students were asked to complete.

Design and methods

In Semester 1, 2016, teaching packages were implemented in three courses: a first year general physics course for non-physics majors, a second year core physics course on fields, and a second year core mathematics course on calculus. Simulations and learning activities were made available in each case and students were surveyed about their opinions of the simulation and the associated activity.

Results

The analysis of the student surveys in each of the three courses is on-going. Students who completed the survey in the second year core physics course provided positive feedback in a number of areas. They were asked to comment on a number of statements with answers ranging from 1 (strongly disagree) to 5 (strongly agree). Students generally agreed with the statement “the simulation helped me learn the concepts related to the activity” (score of 4.3) and “the learning activity was enjoyable” (score of 4.1). Some comments included “visualising helps me understand these counter-intuitive concepts” and “helped in assessing the validity and flaws of my answer”.

Conclusions

Our initial implementations of simulations with associated learning activities has yielded positive feedback from both the students taking the course as well as the teaching staff involved with the course. We will continue to explore the feasibility of this approach in aiding student learning in our courses.

References

Drinkwater, M.J. et al, (2014) Managing Active Learning Processes in Large First Year Physics Classes: The Advantages of an Integrated Approach. Teaching & Learning Inquiry: The ISSOTL Journal, Vol. 2, 75-90, link: http://smp.uq.edu.au/node/2049

ohenwarter, M., Preiner, J. (2007). Dynamic mathematics with GeoGebra. *Journal of Online Mathematics and its Applications.* ID 1448, vol. 7. March, 2007.

Mazur, E. (2004) *Peer Instruction: A User’s Manual*. Upper Saddle River: Prentice Hall.

McIntyre, TJ, Wegener, MJ (2014) Five-Minute Physics: Concise, Interactive, On-line Modules, Australian Institute of Physics Congress, Canberra, December 2014.

Wieman, C.E., Adams, W.K., Perkins, K.K. (2008) PhET: Simulations That Enhance Learning, *Science* 322 (5902), 682 – 683.

Proceedings of the Australian Conference on Science and Mathematics Education, The University of Queensland, Sept 28th to 30th, 2016, page 92-93, ISBN Number 978-0-9871834-5-3.