Overview

This study examines peer instruction as a key method for transforming an undergraduate physics course taught by Matt Davis. The peer instruction method is an active learning pedagogy developed by Harvard physics professor, Eric Mazur. Mazur found the need for change was influenced by research that showed physics students were not able to apply their knowledge to everyday problems, even though their technical knowledge was high. Matt also found that the lecture format was not adequate to foster interaction with and between students and strategies were needed to increase their analytical skills and links to everyday physics in society. Similar to the flipped classroom, students are expected to prepare before lectures and then use class time to consolidate knowledge and use higher order thinking through active learning.

Case study summary

Benefits

- Encourages students to take responsibility for their own learning and come to class prepared so they are not 'blank slates'.
- Peer instruction techniques allow the correct answers to circulate through the class through discussion, debate and critical thinking.
- Peer instruction encourages students to explain complex concepts from a novice’s point of view.
- Using short answer quizzes helps to clarify students’ knowledge and hone analytical skills.
- Lecture time is spent assisting students with conceptual understanding.
- It makes more efficient use of the lecturer’s time to point students to existing resources, such as texts, rather than paraphrasing textbooks in class.
- More opportunities for feedback though peer-to-peer and student-lecturer interactions.
- A large positive response from students, anecdotally.
Issues to consider

• Some students are critical of this technique and feel that they are ‘doing all the learning’. They therefore need to be made aware of the research around and proof of effectiveness of the technique.
• Assessment is used to encourage students to prepare before lectures. Marks are assigned for having made some meaningful attempt (correct or incorrect) at the text-based questions.
• Make sure the teaching team is on board, so students have a consistent experience and support from the school.
• All students need access to a clicker device to participate effectively.

Reasons for adopting the flipped classroom

Matt Davis found that the standard lecture format was not effective, as students weren’t keeping up with the volume and complexity of materials. Eric Mazur, a Harvard physics lecturer, visited UQ to talk about the effectiveness of peer instruction methods over traditional lecture methods. In the article ‘Twilight of the lecture’, Mazur describes how he changed his teaching when he read disconcerting research by David Hestenes that students were able to apply complex theory to mathematical formulae but unable to apply their physics knowledge to everyday problems. Mazur tried simple concept tests on his own students and found the same issue: they lacked fundamental concepts of physics (Lambert, 2013). There was a need, therefore, to find teaching methods that could identify and correct these shortfalls in knowledge using peer instruction and frequent concept tests.

There also appeared to be a lack of connection between teachers and students. Flipping the classroom and introducing peer instruction allowed more opportunities for interaction and to identify where students were having trouble with the content.

Planning

Lectures are designed to create key learning opportunities, so the design and facilitation of learning is emphasised rather than lecturing. Students are given an outline of the activities they will do in class such as problem-solving exercises, demonstrations and worked examples. The ‘concept lab’ is a new idea that merges tutorials with broader activities that link to everyday problems.

Concept tests comprise a large part of the lecture and are designed to encourage critical thinking rather than factual recall. The concept test activity involves the following:

• Concept tests are given in class using Turning Point ‘clickers’ with which students vote on multiple-choice questions. Good question design will result in a workable fraction of correct answers (around 50%).
• The lecturer views the results on screen and there are likely to be incorrect answers.
• Students are then asked to convince their neighbour of their answer. These ‘convince-your-neighbour’ discussions systematically increase the percentage of correct answers, as students explain their concepts from a novice’s viewpoint.
• The question is re-pollled, and there is invariably an increase in correct answers and student confidence as the correct answer circulates through the audience through discussion and debate (Koman, 1995).
If there is prolonged debate, the lecturer roams the audience and provides feedback but not answers. Matt believes that as soon as you give answers away, the learning stops, so it is important to resist this as long as possible.

Students are also asked to complete text-based quizzes—a method Mazur recommends over multiple-choice questions—to encourage learners to think critically about their answers and engage more deeply with content.

Another effective technique is to make deliberate mistakes, as this keeps students on task and thinking critically about what they are being taught.

Flipping the class

- Students are informed early on about the need to prepare before class or miss out on key learning opportunities.
- Class time is used for concept exploration and correcting misconceptions through a variety of activities.
- Use of concept tests in class provides immediate feedback for the lecturer about students’ grasp of content.
- Students also gain immediate feedback and opportunities to correct and share knowledge.
- Peer instruction helps develop a sense of a learning community through focussed discussion and debate.

Online component

- The Blackboard course site is used to post all lectures and resources, including annotated slides.
- The Blackboard discussion tool is used to clarify content.
- Reading quizzes are set up in a different system to enable easier marking of text-based quizzes.

Conclusion

Matt found that he needed to engage students more in lectures and decided to adopt the peer instruction method designed by Eric Mazur to solicit knowledge from students and evoke higher order thinking. By taking this approach, Matt is trying to ‘pull the rug out from under students’, encouraging them to become more active and efficient learners rather than relying on knowledge being fed to them. It is important to sell the concept to students by pointing them to research and explaining that courses taught in this manner have much better outcomes. It is also more efficient, as a lecturer, to focus more on design and facilitation of learning rather than reading out notes from a textbook. Providing active learning with links to authentic examples allows student to problem-solve, learn from each other and acquire more critical thinking skills that can better prepare them to deal with real-world problems.
Useful links

*Twilight of the lecture*, The trend toward ‘active learning’ may overthrow the style of teaching that has ruled universities for 600 years.

*Confessions of a converted Lecturer* [1:20:29] by Eric Mazur

*Journal of peer learning* (Australian) publishes research articles about peer learning across a variety of contexts, predominantly higher education

For further information, see the TEDI Flipped Classroom website.

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