The Innovative Instructor

Center for Educational Resources

Pedagogy Forum

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The Innovative Instructor is a forum of published articles (www.cer.jhu.edu/ii) and a blog (ii.library.jhu.edu) related to teaching excellence at Johns Hopkins

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Leveraging Peer Instruction

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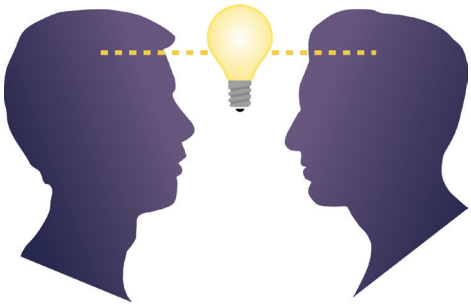
The issue

Instructors often seek student-centered, active-learning teaching practices. These teaching methods are intended to increase student retention and engagement but the ways in which they are implemented is important for success.



Why does it matter

Professor Todd Hufnagel, Department of Material Science and Engineering (MSE), was interested in pedagogical techniques that are potentially more effective than the traditional lecture-based format for the course, *Structure of Materials*.

Professor David Neufeld, Department of Physics and Astronomy, planned to change his teaching approach in a 100-level, large lecture physics course in an effort to identify students' misunderstandings and improve comprehension of the course content.

These courses - *Structure of Materials* and *General Physics* - are gateway courses. Students' mastery of the course learning objectives is critical to success in subsequent, advanced courses. Research demonstrates that the use of active-learning strategies can lead to increased student retention in science and engineering majors.[1, 2]

Faculty solution

Independently, the two professors adopted the Peer Instruction method pioneered by Eric Mazur in his physics courses at Harvard University in the 1990s. Peer Instruction is a popular, research-based pedagogical tool among physics faculty; it is being used increasingly in other disciplines as well. "The basic goals of Peer Instruction are to exploit student interaction during lectures and focus students' attention on underlying concepts," using ConcepTests - short conceptual questions on the topic being discussed.[3]

In Mazur's implementation of Peer Instruction, students first gain exposure to content before class by reading texts, watching videos, or completing other activities. Instructors then solicit pre-class feedback on that content, usually in the form of questions about what students found difficult or confusing.

The in-class cycle is as follows: after a brief presentation on the topic, the instructor presents a question (i.e., ConcepTest) to the class. Students individually respond after briefly reflecting on the question. The instructor then asks students to discuss their answer, with 1-2 other students who have different answers before responding again. The instructor always debriefs the question by discussing with the students the rationale behind the correct answer and providing a short lecture on the underlying concept, depending on the percentage of students who answer correctly.

Professor Hufnagel's use of Peer Instruction starts with the introduction of a ConcepTest with four multiple-choice answers, often including an illustration. He asks the students

[1] Felder, R., G. Felder, and E.J. Dietz. (1998) "A Longitudinal Study of Engineering Student Performance and Retention. V. Comparisons with Traditionally-taught Students." Journal of Engineering Education, 87(4), 469-480.

[2] Springer, L., M. Stanne, and S. Donovan. (1999). "Effects of Small-Group Learning on Undergraduates in Science, Mathematics, Engineering and Technology: A Meta-Analysis," Review of Educational Research. 69(1), 21-5.

[3] Mazur, E. (1997). Peer Instruction: A User's Manual. Upper Saddle River: Prentice Hall. Page 10.

to think about the question individually before voting using clickers. He then uses the iClicker software to show a histogram of the results. Students talk with their neighbors for a few minutes and then vote again. Professor Hufnagel shows the new results, explaining which answer is correct and why. The depth of explanation depends on how well the class is mastering the concept. If, based on the histogram, the class has not mastered the concept, he will ask another question on the same concept, repeating as necessary.

> Sodium chloride and magnesium oxide have the same crystal structure. Which one has the higher melting temperature?
>
> (a) NaCl
> (b) MgO
> (c) They're about the same
> (d) No way to tell without more information.
>
> (Note: This would be accompanied by a periodic table.)

Example question

In Professor Neufeld's physics course, students watch online content before class as a replacement for the traditional lecture. By flipping the lecture, Professor Neufeld can spend class time using ConcepTests. If there is general agreement about the correct answer after the first vote, he moves on to the next question. If there is substantial disagreement, then students are directed to discuss their answers for 1-2 minutes with those sitting around them. After a second vote, Professor Neufeld asks students who changed their answers to explain why they did so. This often leads to further class discussion.

Results

In Professor Hufnagel's course, students were administered a concept inventory at the beginning and end of a semester during which he lectured and the semester during which he employed Peer Instruction. The concept inventory included 20 questions measuring student mastery of the course learning objectives. During the semester in which he used Peer Instruction, student gains were twice those of the students in the semester in which he primarily lectured. Additional assessments will be conducted in the future to see if these gains are replicated.

Professor Neufeld used the Force Concept Inventory (FCI), a standard assessment instrument used in university-level Newtonian physics. Student learning gains measured by the FCI tend to be higher in courses with active-learning strategies compared to traditional lecture courses. In Professor Neufeld's class, results were similar to those reported by faculty at other universities using traditional lecture methods. The gain was not what he hoped, but this is not uncommon. Sometimes the method requires a few tweaks. While disappointed, he suspects the results reflect the fact that it was his first time using Peer Instruction. He is committed to teaching with Peer Instruction again, and the FCI will be used in future semesters to determine if gains increase as he acquires more experience.

Other thoughts

One of the challenges of using Peer Instruction is that instructors cannot script class time as they can with a lecture. It is difficult to estimate how many ConcepTests can be completed during class because the length of follow-up student discussions varies. Despite some concerns about how to structure class time, both Hufnagel and Neufeld were pleased with how engaged students were during class discussions.

The first time you try Peer Instruction can be challenging, especially when creating or selecting ConcepTests. To assist instructors, Julie Schell and Eric Mazur established The Peer Instruction Network (https://www.peerinstruction.net), a database of Peer Instruction users with links to their available ConcepTests.

Peer Instruction can be used as one of several active-learning strategies during class time. For example, at several stages in Professor Hufnagel's course, groups of students spent class time working out detailed problems that traditionally might have been presented as part of a lecture. Professor Hufnagel mentors student groups as needed during these exercises.

Additional resources

- Mazur, Eric. *Peer Instruction: A User's Manual*. Prentice Hall, 1997
- *Turn to Your Neighbor Blog*. The Official Blog of Peer Instruction: http://blog.peerinstruction.net
- Article on "flipping the classroom", *Lectures On Demand*: http://www.cer.jhu.edu/ii/InnovInstruct-Ped_LectOnDmnd.pdf
- Article on "clickers", *In-Class Voting ('Clickers')*: http://www.cer.jhu.edu/ii/InnovInstruct-Tech_Clickers.pdf

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Dr. Julie Schell is the senior educational researcher within the Mazur Group at Harvard University and an instructional designer at the Center for Teaching and Learning at the University of Texas at Austin. She is an expert in innovative flipped teaching and Peer Instruction. She co-founded the Peer Instruction Network and authors the official Peer Instruction blog, *Turn to your Neighbor*.