

Rethinking the Way College Students Are Taught

by Emily Hanford

It's a typical scene: a few minutes before 11:00 on a Tuesday morning and about 200 sleepy-looking college students are taking their seats in a large lecture hall - chatting, laughing, calling out to each other across the aisles. Class begins with a big "shhhh" from the instructor.

This is an introductory chemistry class at a state university. For the next hour and 15 minutes, the instructor will lecture and the students will take notes. By the end of class, the three large blackboards at the front of the room will be covered with equations and formulas.

Students in this class say the instructor is one of the best lecturers in the department. Still, it's not easy to sit through a long lecture, says student Jimmy Orr. "When it's for an hour you kind of zone out for a little bit," he says.

Student Marly Dainton says she doesn't think she'll remember much from this class.

"I'm going to put it to short-term memory," she says. Once she takes the exam, Dainton expects she'll forget a lot of what she learned.

One of the Oldest Teaching Methods

Research conducted over the past few decades shows it's impossible for students to take in and process all the information presented during a typical lecture, and yet this is one of the primary ways college students are taught, particularly in introductory courses.

It's a tradition going back thousands of years.

"Before printing, it was very difficult to create books, and so someone would read the books to everybody who would copy them down," says Joe Redish, a professor of physics at the University of Maryland. He points out that the word "lecture" comes from the Latin word meaning "to read."

Redish is trying to change the way college students are taught. He says lecturing has never been an effective teaching method, and now that information is so easily accessible, lecturing is a waste of time.

"With modern technology, if all there is is lectures, we don't need faculty to do it," Redish says. "Get 'em to do it once, put it on the web, and fire the faculty."

Redish has been teaching at the University of Maryland since 1970. When he started, he lectured because that's the way he had been taught. But after a few years in the classroom, Redish was meeting with one of his mentors, a famous physicist named Lewis Elton who had begun doing research on education.

"He asked me, 'How's your teaching?'"

Redish told him it was going well, but that he seemed to be most effective with the students "who do really well and are motivated" about physics.

Elton looked at Redish, smiled, and said, "They're the ones who don't really need you."

"That was like an arrow to the breast!" says Redish.

He knew that Elton was right. Most of the students in his lecture classes were not motivated to learn physics, and they didn't seem to be learning much. Redish thought back on his own experience as a college student and realized that he didn't learn much in lecture classes either.

"When I had a question, I would find the TA," he says. "He would explain stuff to me. I would find other students. I learned how to learn physics on my own."

How People Learn

Redish wanted to reach the students who weren't teaching themselves. So he began trying to better understand how people learn.

This was the 1970s and 80s, a time when cognitive scientists were making big breakthroughs in their understanding of how the human brain processes and retains information. At the same time, a small and growing group of physicists was becoming interested in the questions that kept Redish up at night: What do students learn in a traditional lecture-based physics class, and are there ways to teach them better?

Cognitive scientists determined that people's short-term memory is very limited – it can only process so much at once. A lot of the information presented in a typical lecture comes at students too fast and is quickly forgotten.

Physics education researchers, among whom Redish is now a leader, determined that the traditional lecture-based physics course where students sit and passively absorb information is not an effective way for students to learn. A lot of students can repeat the laws of physics and even solve complex problems, but many are doing it through rote memorization. Most students who complete a standard physics class never understand what the laws of physics mean, or how to apply them to real-world situations.

It may seem obvious that lecturing isn't the best method to get students thinking and learning. Project-based learning and other interactive approaches have been popular in elementary and secondary schools for a long time, and of course the discussion-based seminar is an age-old approach. But lecturing is still the dominant teaching method in large classes at the college level, and also at many high schools - especially in the sciences. Experts say different approaches to teaching large classes can help more students learn, and help them learn better.

"We want to have a class where everyone can be successful because we need everyone to be successful," says Brian Lukoff, an education researcher at Harvard who is studying ways to more effectively teach large classes.

"We need to educate a population to compete in this global marketplace," says Lukoff. We can't do that by relying on a few motivated people to teach themselves. "We need a much larger swath of [the] population to be able to think critically and problem-solve."

Lukoff works with Harvard physicist Eric Mazur, one of the pioneers in developing a new way to teach large classes. Mazur calls his approach "peer instruction."

Discovering a New Way to Teach

Like Redish at the University of Maryland, Mazur began his teaching career by giving lectures. But in the early 1990s Mazur read about the research being done by Redish and other physicists interested in education. Mazur realized that even many of his Harvard students were getting through class by memorizing information but not really understanding the fundamental concepts of physics.

One day, after he discovered this, Mazur decided to spend a big chunk of class time reviewing a fundamental concept. Half his students had gotten a question about this concept wrong on a recent test. So Mazur gave what he thought was a thorough and thoughtful explanation of the concept. He went slowly, putting all kinds of helpful diagrams up on the board.

"I thought I'd nailed it," he says. "I thought it was the best explanation one could possibly give of this question."

Mazur triumphantly turned around. "Any questions?" he asked. The students just stared at him.

"Nobody raised their hand and said, well but what if this and what if that, simply because they were so confused they couldn't," he says. "I didn't know what to do. But I knew one thing. I knew that 50 percent of the students had given the right answer."

So for reasons he can't remember, Mazur told the students to discuss the question with each other.

"And something happened in my classroom which I had never seen before," he says. "The entire classroom erupted in chaos. They were dying to explain it to one another and to talk about it."

Mazur says after just a few minutes of talking to each other, most of the students seemed to have a much better understanding of the concept he'd been trying to teach.

"The 50 percent who had the right answer effectively convinced the other 50 percent," he says.

Here's what Mazur has figured out about what goes on when the students talk with each other during peer instruction:

"Imagine two students sitting next to one another, Mary and John. Mary has the right answer because she understands it. John does not. Mary's more likely, on average, to convince John than the other way around because she has the right reasoning."

But here's the irony. "Mary is more likely to convince John than professor Mazur in front of the class," Mazur says.

"She's only recently learned it and still has some feeling for the conceptual difficulties that she has whereas professor Mazur learned [the idea] such a long time ago that he can no longer understand why somebody has difficulty grasping it."

That's the irony of becoming an expert in your field, Mazur says. "It becomes not easier to teach, it becomes harder to teach because you're unaware of the conceptual difficulties of a beginning learner."

Peer Instruction

Mazur now teaches all of his classes using a "peer-instruction" approach. Rather than teaching by telling, he teaches by questioning. Mazur says it's a particularly effective way to teach large classes.

Here's how he does it: Before each class, students are assigned reading in the textbook. Pretty standard for a lecture class, but if you talk to college students you'll find that many of them don't bother with the reading ahead of time. They come to class to figure out what information the professor thinks is important, then they go to the textbook to read up on what they didn't understand.

"In my approach I've inverted that," says Mazur.

He expects students to familiarize themselves with the information beforehand so that class time can be spent helping them understand what the information means.

To make sure his students are prepared, Mazur has set up a web-based monitoring system where everyone has to submit answers to questions about the reading prior to coming to class. The last question asks students to tell Mazur what confused them. He uses their answers to prepare a set of multiple-choice questions he uses during class.

Mazur begins class by giving a brief explanation of a concept he wants students to understand. Then he asks one of the multiple-choice questions. Students get a minute to think about the question on their own and then answer it using a mobile device that sends their answers to Mazur's laptop.

Next, he asks the students to turn to the person sitting next to them and talk about the question. The class typically erupts in a cacophony of voices, as it did that first time he told students to talk to each other because he couldn't figure out what else to do.

Once the students have discussed the question for a few minutes, Mazur instructs them to answer the question again.

Then the process repeats with a new question.

What Mazur has found over nearly 20 years of using peer instruction is that many more students choose the right answer after they have talked with their peers. And it's not because they're blindly following their neighbor's lead. By the end of the semester, students have a deeper understanding of the fundamental concepts of physics than they did when Mazur was just lecturing. Students end up understanding nearly three times as much now, measured by a widely-used conceptual test.

In addition to having a deeper grasp of concepts, students in Mazur's classes are better at solving conventional physics problems, despite the fact that Mazur no longer spends class time at the board doing problems. He says this shows something that may seem obvious.

"If you understand the material better, you do better on problem-solving," Mazur says. "Even if there's less of it done in class."

Peer instruction has proven effective in a range of subjects from psychology to philosophy.

A Skeptical Audience

College students typically come into peer instruction courses skeptical.

"Basically my entire life I have been in a situation where a teacher stands up and talks and then you take notes and try to absorb the information as well as you can," says Ryan Duncan, a sophomore in Eric Mazur's physics class at Harvard.

"I've developed a pretty good system to deal with that and revamping my entire education 'philosophy' for this one class was a bit daunting."

But Duncan says he has come to appreciate Mazur's approach.

His classmate Stacey Lyne says she has too. She says it will be frustrating to go back to the traditional approach when she takes classes from other teachers.

"I know I'm frustrated now with some of my other classes when I go to lecture and I have to just sit there and take in information and I don't really get the opportunity to think about what I have just learned," she says. Lyne says she's learning more in this new way.

But getting Lyne's other professors to stop lecturing will be a hard sell. Change is slow in the academy, and professors tend to be rewarded for focusing on their research, often at the expense of their teaching.

From American RadioWorks' The Tomorrow's College Series, Episode: Don't Lecture Me. A production of American Public Media. Article available online at <http://americanradioworks.publicradio.org/features/tomorrows-college/lectures/rethinking-teaching.html>. Retrieved 10/18/11 at 1:13pm. Original airdate: 9/24/11.