Guest Column: Active Learning Strategies Lead to Better Student Outcomes

Department of Astronomy
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You're lecturing to your introductory college class about one of your favorite topics. You've carefully explained the background and relationships between the variables involved in understanding the topic. You've shown a few examples or perhaps used a movie or animation or demonstration to help your students connect the abstract representations and ideas to the real world. You assign thoughtful homework problems, and you encourage the students to ask questions if they don't understand, either in class or during your office hours. You're known as a good lecturer, and your students always rate you highly at the end of the semester. Yet when you give your exam, you're dismayed to see how many of them can't answer straightforward questions of the type you covered in class and assigned as homework. So why does the same thing happen to instructors all over the country?

For several decades, science education researchers have been investigating which teaching methods best help students overcome common learning difficulties and develop more expert-like discipline, knowledge and abilities. The results of numerous studies involving tens of thousands of students from colleges and universities all across the country reveal that the students who work together in classrooms that use evidence-based active learning strategies can significantly outperform their peers who sit passively and listen to traditional lecture-based instruction. Active learning classrooms require students to participate in constructing and evaluating their understandings, in class, while working collaboratively in small groups or teams.

The cognitively challenging tasks that students encounter force them to intellectually engage in a critical exchange of ideas, make predictions and provide sophisticated explanations while they grapple with real-world scenarios and complex problems. Faculty new to the use of active learning strategies are often pleasantly surprised the first time they hear their students engaging in intense discussions about how best to go about solving a hard problem, or when students make use of different concepts from the class to defend their thinking about a complex situation. More and more we find that even students who are accustomed to zoning out after 10 minutes (at best) and playing on their phones (at worst) report a greater level of personal satisfaction and reward from classes that appropriately challenge them and support their learning using active learning methods. Oh, and they learn more, too!

Over the past year, a group of experienced physics and astronomy educators and STEM education researchers at the UA has engaged in a reform effort to implement active learning strategies into the large enrollment ? 200-plus students ? introductory calculus-based physics course. This physics course reform effort is one of several course transformations happening in foundational STEM courses across campus as part of the UA AAU Undergraduate STEM Education Project. These reform efforts focus on the promotion of information and quantitative literacy, the use of real-life applications in problem solving, and the use of models to develop
conceptual understanding.

To get our students to engage in collaborative problem solving every day in class took the efforts of a team involving tenured faculty members, graduate and undergraduate students, all working together on both curriculum development and classroom instruction. We integrated carefully sequenced, evidence-based instructional strategies focused on well-known problem solving difficulties that students commonly experience when working through challenging quantitative physics problems. Students had to come to class ready to negotiate and build consensus on their conceptual understandings, problem-solving strategies and appropriate mathematical representations. Additionally, one day each week, which would typically be used for lecture, we had students, in groups of 25, attend a one-hour tutorial session. These sessions were facilitated by an undergraduate or graduate teaching assistant who had been trained in the implementation of active learning strategies. During these tutorial sessions, students worked on conceptual activities designed to elicit and confront naïve ideas and reasoning difficulties students commonly have with specific physics topics.

To gauge the success of this course reform effort, we created a set of assessment questions that tested both conceptual understanding and quantitative problem solving ability. The same set of questions was used on the in-term and final exams in the reformed course and a traditionally taught calculus-based physics course. It’s important to note that the instructor for the reformed course was an astronomy postdoc who was very familiar with active teaching strategies but who had never taught a physics course before. The traditional course was taught by a full professor who is one of the most experienced and best-liked teachers in the physics department. Studying the two classes using the COPUS teaching observation tool revealed a much greater variety and amount of time spent by the instructor and students in the reformed course on activities that go beyond lecturing and listening (see results in pie charts here [1]). Additionally, students in the active learning, reformed physics course consistently outscored their peers in the traditionally taught, lecture-based physics course on the final exam overall (see the left bar graph [1]) and on each individual question on the final (often by more than a letter grade, as seen in the right bar graph [1]). Note that similar results were also observed on the last two in-term exams.

If you’re interested in learning about how to best implement different active engagement instructional strategies, you may wish to join one of the Faculty Learning Communities or attend one of the professional development workshops being run by the UA AAU Undergraduate STEM Education Project; contact Jane Hunter, jhunter2@email.arizona.edu [2].

A word of advice on getting started: Don’t try to do too much too soon. Start with something reasonable that really fits your course goals, your discipline topics and your personal teaching style. And work at using it in your course for a while, until you own it. Even one active learning strategy used well can significantly improve student learning beyond just having them listen to you.

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