Are Students' Perceptions of Teaching and Learning always Valid?

On 18 November, Louis Deslauriers (Director of Science Teaching and Learning in FAS and Senior Preceptor on Physics) and Logan McCarty (Director of Science Education and Lecturer on Physics, Chemistry and Chemical Biology) continued our 2019–2020 Faculty Lunch series with a presentation drawn from their recent article in the Proceedings of the National Academy of Sciences, "Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom." In this article, which has received substantial attention both at Harvard and from scholars of teaching and learning further afield, Deslauriers, McCarty, and coauthors Kelly Miller, Kristina Callaghan, and Greg Kestin, report on how much more their students learned when exposed to the physics concepts through active- rather than passive-modes of instruction, despite the students *feeling* as if they learned less. Among the many topics we explored were the following:

- The reasons why conventional lectures typically are less effective at promoting student learning than we would like to think. Deslauriers ably summarized three of the limitations inherent in typical, passive lectures, two of which afflict students and one of which afflicts their instructors. Students, for their part, are underserved by listening passively to lectures because
    - typically they are not "primed" or motivated to assimilate deeply the material which the lecturer is presenting, given that they are not also presented with an authentic problem to which they might apply it; and
    - it is human nature for any novice encountering a new concept or body of knowledge to overestimate the extent to which their in-the-moment comprehension ("I'm able to follow this lecture right now!") represents the kind of deeper learning that will last beyond the lecture's end. The difficulty that novice learners experience in distinguishing what they do and do not understand is sometimes referred to as the "Dunning-Kruger effect," or the "Illusion of Knowing."

  Instructors, meanwhile, often fail to achieve their anticipated results because they can, at best, only speculate as to the mental models—including the all-important misconceptions—which students will bring to their material, and thus often miss opportunities to clarify misunderstandings or find new ways to relate the material they are teaching to their students.
- The value of active learning as the most efficient/effective means of overcoming these three deficiencies in the conventional ("passive") lecture format. When used at the beginning of a lesson, active instructional techniques can prime student learning by introducing a problem that they lack the skills to solve, thereby motivating and contextualizing a subsequent lesson that will teach them the skills and concepts necessary to solve the initial problem. Daniel Schwartz pioneered research in this field

and described this use of active learning at the beginning of lecture as creating a "time for telling." Providing students with an opportunity to engage with a problem *before* a lecture increases the effectiveness of the subsequent lecture. The opportunity which it provides students to solve problems also helps them identify precisely what they do and do not understand, avoiding the aforementioned Dunning-Kruger effect or Illusion of Knowing. Active learning indicates to both the students and the instructor what concepts are well understood and which are lack, allowing the instructor to directly address student misconceptions to which they may otherwise be unaware.

- The (sometimes hidden) mastery required to implement some kinds of active learning. Using active learning in the classroom involves ceding some amount of control to the students. Asking students engaging questions is a great way to uncover their misconceptions; however, it also requires addressing and resolving these misconceptions in real-time, which can be particularly challenging if the student misconceptions are unexpected by the instructor. The ability to address student questions that are evoked by active learning exercises quickly and meaningfully can often require even more preparation and expertise than providing a conventional lecture. During a lecture, the instructor gets to be in control of the all the topics that come up. During active learning, student questions and comments can bring up unanticipated topics and confusions, requiring the instructor to engage with student questions and comments in a time-efficient manner to be able to cover the desired material. It should therefore be noted that implementing active learning is far from "taking the easy way out" by giving students more agency over their learning; rather, implementing active learning requires an intense amount of instructor preparation and expertise to engage with student questions, concerns, and misconceptions without the class grinding to a halt. The point of active learning is not to "step back" and let students do "all" the work—it's rather to dedicate your expertise to creating the holistic system in which students can learn deeply while developing critical thinking skills. This often involves giving students very clear directions when starting an active learning exercise, indicating what you want students to do during an activity and how you want them to report back to you.
- The paradoxical fact that students often report feeling like they have learned less through active learning, when in fact they have learned more. Students are novices with regard not only to the content they are being taught, but also to what it means to learn that material deeply. As experts, it is easier for instructors to diagnose what skills and concepts students have mastered than it is for students to diagnose their own learning. Implementing active learning often involves asking questions of students that they may not be ready to answer in the time given, which can understandably lead to student frustration. The act of asking students questions on which they struggle can cause them to feel like they are not learning the material well, which may be why they rate their "feeling of learning" as relatively low compared to when they receive a conventional, passive lecture. However, the act of making students engage with challenging questions (and providing them with feedback afterwards) has been repeatedly shown to improve to improve student learning, because it requires students to intellectually engage with the material. This phenomenon in which student learning improves by being challenged with

questions is sometimes referred to as “the testing effect,” and is elegantly described in Make it Stick.

Faculty interested in learning more about how to introduce more active learning techniques into their courses are welcome to contact the Bok Center. We would be happy to collaborate with you on the design of in-class activities that are well-aligned with the concepts you hope to teach and the atmosphere and persona that you are seeking to cultivate. As Deslauriers and McCarty emphasized, the term “active learning” covers a broad spectrum of activities. Here are a few resources available online:

- Carl Wieman developed a litany of resources that are freely available as part of his Science Education Initiative, including guidance for instructors and videos of active learning in action.
- Eric Mazur has pioneered the method of peer instruction, in which students respond to multiple-choice questions in class using polling software, then discuss their answers with each other, then poll their answers again before having a whole class discussion. Videos of Professor Mazur using peer instruction can be found here, and were captured as a part of this Harvard Magazine article.