Restructuring Classes Can Level the Playing Field

A study of university-level physics classes shows that changes in course structure can help to eliminate grade gaps between student groups with different races, ethnicities, or genders.

By Katherine Wright

When it comes to addressing diversity in physics, a common refrain from those against change is that inclusion lowers standards [**1**, **2**]. Believers of this dictum think that efforts aimed at increasing the number of underrepresented students studying physics—and keeping them in the field—requires putting in place accommodations that will diminish excellence in the field. Results from a new study that looks at sources of demographic grade gaps in undergraduate classes show the opposite: leveling the playing field does not require lowering standards [**3**]. The study finds that relatively simple adjustments to the structure of a course—not its content—can remove grade gaps between white male students and those from marginalized groups. The researchers behind the study hope that the findings will motivate educators and institutions to reflect on their teaching methods and implement changes that will make the physics classroom more equitable.

New teaching methods offer a more inclusive environment without sacrificing standards.
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"Making small changes to a course's structure can eliminate equity gaps in course grades," says Cassandra Paul, a physics education researcher at San José State University, California, and one of the people behind the new study. "It's not the students that need fixing, it's how we serve them."

The study conducted by Paul, together with David Webb of the University of California, Davis, considered two course-format alterations. One switched up how the students were taught, the other how they were assessed. The teaching-method change, which the duo terms "concepts first," involved rearranging the order in which the teacher presented the elements to be learned. Traditionally, university lecturers take a topic-by-topic approach, which drip feeds the concepts to students while simultaneously starting them on complex calculations. The concepts-first method, by contrast, splits these two elements apart. In the first 60% of the semester the teacher familiarizes the students with the concepts they need to understand, drilling down into the details of each one. The semester then finishes up with the students using that knowledge to solve problems on a variety of topics.

The assessment change allowed students to retake exams without penalty. In the unaltered version of this class, the students were continuously quizzed on what they were learning in weekly 20-minute tests, with a final exam at the end of the semester. In the retake version, the weekly tests were swapped with fortnightly ones. That left an intervening week between tests, where students were given the option to retake the previous week's test. The retake test covered the same material, and, if higher, the retake grade supplanted the original score. Retaking was optional and was only allowed for the fortnightly tests and not the final exam.

The concepts-first idea was implemented by Webb in an introductory calculus-based physics class designed for physics and engineering majors. In the same semester, he taught the class to two separate groups of students, with one group following a concepts-first format and the other topic by topic. "Everything but the approach was kept the same," Webb says. "I used the same material, the same homework problems, and they had the same teacher." The retake option was put in place by other teachers in four introductory physics courses for biological science majors. In all cases the students had no knowledge of how the classes would be organized when they signed up.

Paul and Webb found that students with backgrounds traditionally classed as underrepresented in physics received higher grades in the restructured versions of both courses. The concepts-first change eliminated the grade gap between underrepresented minorities versus everyone else. A grade gap persisted between men and women. On the other hand, the retake option eliminated the grade gap for women but not for underrepresented minorities as a whole.

As to why some structural changes benefited some groups more than others, Webb explains that each group likely faces different obstacles. Support for this view comes from previous studies showing that, on average, students who identify as women and as coming from an ethnic minority have more of a grade gap than those who claim only one of these identities. "We suspect this [finding] is just evidence that structural racism and structural sexism are different things and are probably largely due to different structures in the particular physics courses," Webb says. "What these course structures are and exactly how they work would be interesting to know but is beyond the scope of [this study]."

As for the grade-gap eliminations they do observe, Paul and Webb point to several possible explanations. The concepts-first approach, for example, increases student interaction with the fundamental ideas underlying the topics being studied. Likewise, the retake option improves understanding by entrusting students with the opportunity to learn from their mistakes, Paul says. "These methods both aim at increasing productive student engagement in an attempt to improve the courses for everyone," she adds.

"This [study] provides a clear example of how structure can make a difference, providing equity in classroom achievement," says Andrew Heckler, who studies physics education at the Ohio State University. That the team finds that this parity can be gained without changing the course content or the depth in which it is covered is particularly important, he adds. "It is common for us in the physics community to assume that improving equity means lowering standards. Sometimes this assumption is inadvertent and unnoticed, sometimes it is explicit. In any case, it is good to 'control' for this issue so that this [view] can be refuted."

Despite his excitement about the results, Heckler does offer a word of caution on extrapolating the outcome to all science classes. "This work looks at two course changes at one institution," he says. "The results need to be replicated many times at a variety of institutions and with a variety of instructors, populations, and course-structure changes before we can make general statements like 'changing the structure reduces inequity."'

Paul and Webb agree that the results need to be replicated. But they and Heckler also note that some of that additional evidence already exists. For example, a recent study found significantly narrower achievement gaps in courses taught via "active-learning" methods, where the students engage in the course material through discussions or problem solving, than for those taught via traditional lecturing, where students sit and listen to the instructor [**4**]. Traditional lecturing is the pedagogy of choice of most US universities, Webb says. But studies increasingly show it's a poor method for teaching any student.

Even with this growing evidence, the view persists that the students, and not the course, are the "problem" when it comes to differences in learning outcomes. Webb thinks that this attitude remains entrenched partly because change is difficult but also because physics educators have yet to be convinced of the findings. He and Paul hope that this study could be a tipping point in swaying opinions. Poor performance, particularly in introductory courses, is one of the biggest reasons that students—of all backgrounds—give for dropping out of science. "We should all want to rectify that," Paul says.

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