EDITORIAL

Drop the chalk

A diverse scientific workforce; policy-makers who recognize the importance of science; a voting public that understands the scientific process (and even some facts about the ancient universe and climate change, too)—this has been the mantra of the scientific community, but these words don't match actions. Look no further than the way science is still taught at universities—it's no wonder that there is a struggle to recruit students to science. That is costing society a generation of researchers, educators, a population that better grasps science, and maybe more.

Despite evidence to the contrary, most science departments believe that the only way to produce scientists is to bludgeon young people with too much material, in the wrong setting, at the wrong time, and with the wrong kinds of assessments. The rationale is that only by mastering an abundance of facts and quantitative skills can someone become a scientist—and that's where one must start, not finish.

Lecture halls have been fitted with audience response system technology (like clickers) to improve student engagement.

I understand the people who make this case because I used to be one of them, a professor filled with righteousness about all of the things that students had to learn. Then I went into administration, saw the data on how poorly universities were doing, and changed my mind. A smart social science colleague told me that instead of weeding out, we should be weeding in. That rocked my world. Even so, I mostly failed at getting the PowerPoint and the big chalk out of the hands of my colleagues who were convinced that the old way was the right way.

The irony of a Ph.D. education is that the research part actually does the right thing by getting students to learn material when they need it for their research. Lots of research on learning supports the idea that we learn new things best when we need them. Legendary biologist E. O. Wilson sounded off on this matter to *The Chronicle of Higher Education* last year. He was unhappy about science teaching and lamented the "intellectual triathlon" that is used to turn off inquisitive young minds, referring to the dogmatic belief that all scientists have to start by running the gauntlet of biology, chemistry, and physics as "nonsense." "The right way to create a young scientist who's going to be on fire by the time they're in college," he said, "is to let them pick something, some subject that has really excited them."

We know from Nobel laureate Carl Wieman and other scholars that active learning that is heavy on group work and discussion creates a better opportunity for students of all identities to succeed in science. Yet 55% of all science instruction in the United States is still traditional lecturing. Only 27% has a modest intervention such as multiple-choice questions with clickers to engage students during class. And only 18% is designed for students to work through problems together in class after learning didactic material in advance. This is the face of modern science education, even when a Nobel laureate has shown that lectures don't work effectively.

Whom do lectures work for? They work for those who love to memorize facts and equations and can "plug and chug" on exams. They work for those who are not subjected to social cues that make sitting in a large lecture hall and taking high-stakes tests intimidating. They work for those who look like the people who were in the classrooms when this method of teaching was invented. That's not fair and it's not going to cut it for the future of science and the planet.

There are plenty of green shoots, especially Kelly Hogan's reinvention of large lectures by including active learning for groups of up to 400 students, wrap-around programs like Freeman Hrabowski's Meyerhoff Scholars that surround students with support and place them in a cohort that increases their chances of success, and institutions like Xavier University of Louisiana that are lapping well-known research universities in educating African Americans who are admitted to prestigious medical schools. But despite these impressive examples, the future mostly languishes in lecture halls while the PowerPoints and big chalk drone on.

How do we get more folks into science? Let's start by not running them off.

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