Diverse suggestions for improving physics teaching FREE

Peter Hansen

Physics Today **67** (12), 12 (2014);
https://doi.org/10.1063/PT.3.2602

time. After all, isn't practice how American students master the game of baseball, the piano, and the skills of speaking, reading, and writing? Isn't that also how Chinese, Korean, Indian, and Singaporean students master physics and mathematics? And isn't that the way we train our Physics Olympiad finalists (http://www.aapt.org/physicsteam/2015/program.cfm), who by the way, are consistently sons and daughters of the segment of the population represented in the article's photograph?

I hope we don't change our PhD programs to accommodate women and minorities—or, more broadly, non-Jewish and non-Asian Americans. Let me finish by paraphrasing Euclid's famous quip when Egyptian ruler Ptolemy I asked him if there was an easier way to learn geometry than by reading *The Elements*: There is no American road to physics and mathematics.

References

1. National Education Association, Committee of Ten on Secondary School Studies, *Report of the Committee of Ten on Secondary School Studies: With the Reports of the Conferences Arranged by the Committee*, American Book Co (1894), p. 17.
2. US Department of Education, National Center for Education Statistics, *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*, NCES 98-049, US Government Printing Office (1998).
3. National Assessment of Educational Progress, "Are the Nation's Twelfth-Graders Making Progress in Mathematics and Reading?" http://www.nationsreportcard.gov/reading_math_g12_2013.

Sadri Hassani
(sadri.d.hassani@gmail.com)
Illinois State University
Normal

■ **A major emphasis** in the article "Psychological insights for improved physics teaching" is success in diversity by having teachers understand "students' perspectives" or "mindsets." Diversity should not be denied, but it cannot and should not be created by decoding students' mindsets. Consider the authors' description: "the conventional, if erroneous, wisdom that the population can be divided into math-brained and non-math-brained people." It is wisdom, but it is not erroneous. We've all seen our children or other students who are one or the other.

A math-brained student who does not also possess a great spark of curiosity will not transform into a physicist, no matter how good the teacher is. If the curiosity is there, then for all but the brilliant ones, a lot of hard work lies ahead. I speak from my own experience of quitting physics three times at different levels but succeeding in the fourth attempt. Teachers can psychoanalyze their students' mindsets forever, or imagine some intervention, but that doesn't make them better teachers or produce more physicists.

For some, the curiosity required for physics was stimulated by the science fiction of the 1950s, *Star Trek* in the 1960s, and the US space program of the 1970s; that was before smartphones, video games, and the overdone special effects in science fiction movies today.

I submit that improvement in student success in physics will come not from analyses of diversity and mindset but from the inherent pleasure of mathematics for those so brained and, for all, the curiosity often stimulated in the labs—one place where a good teacher can make a difference.

Peter Hansen
(phansen1@hotmail.com)
Torrance, California

■ **In their article** Lauren Aguilar, Greg Walton, and Carl Wieman stress the importance of knowing the psychological mindset of minority physics students and using nuanced "psychological interventions" to shrink the academic gender and minority gaps. The authors provide many interesting examples of how well-meaning encouragement and feedback given to improve student success can, in fact, further widen those gaps.

Although I find most of what the authors describe compelling, I am disturbed by the data presented in figure 3a, which shows that "values-affirmation interventions" can considerably reduce the gender gap: They bring up the average exam scores of women and bring down the average exam scores of men. The error bars—representing the standard error—do not come close to overlapping between the control and intervention groups in either demographic. Thus the figure would suggest that while the intervention reduces the gender gap, it also reduces the success rate of the top physics students in a manner that is statistically significant.

I'm disturbed that the authors ignore a seemingly negative consequence of focusing more on shrinking the gap than on boosting overall performance. Perhaps such interventions are supplanting some of the time devoted to teaching physics skills, or perhaps they are sending other unintended messages to top students, who may themselves be an academically and culturally distinct minority. On the other hand, it is entirely possible that the error bars are large enough to obviate such a conclusion, and therefore all of the reported intervention gains are also insignificant.

In the end, we must ask an inconvenient question: Which is more valuable—training the best future physicists or equalizing success across gender and culture? I'm not sure I have a cogent answer.

Aaron Slepkov
(aaronslepkov@trentu.ca)
Trent University
Peterborough, Ontario, Canada

■ **Aguilar, Walton, and Wieman reply**: We appreciate the interest that our article generated. The example provided by Robert Megginson shows how difficult it is for even the most well meaning, such as the dean in his story, to recognize aspects of the classroom (or lab) that are important to those who come with different experiences and perspectives. That story emphasizes the need to turn to research, as we discussed in our article, rather than relying on one's own opinions and experiences to understand the perspectives of underrepresented groups and how those perspectives may affect the quality of their experience and success in educational settings.

When people enter physics environments, they want to know, "Is anyone like me here? Will people value and respect me here?" For women and ethnic-minority students these questions have a special resonance, so they notice cues, like the absence of women, that other people overlook. Research shows that changing how students interpret those cues so that women and minorities feel valued and respected can unleash their potential. Such interventions don't change the curriculum or the standards. They don't give some students a leg up over others. They level the playing field.

William DeBuvitz underscores the importance of cultural stereotypes about scientists who are represented as either "antisocial eccentrics" or "so bright that everything comes easily to them." As he says, such a representation turns students off. Indeed, the research we referenced shows that a fixed mindset that some people are intelligent and other people just aren't leads students to view effort negatively. If you have to work hard, it means you're not "smart." That mindset makes students less persistent, less resilient, and worse learners. We echo DeBuvitz's recommendation that physicists communicate the need for "real academic work" and the idea that "one doesn't