Meeting challenges and facing the music in physics education FREE

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letters

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In their article "Transforming Physics Education" (PHYSICS TODAY, November 2005, page 36), Carl Wieman and Katherine Perkins make some very useful observations. I certainly agree that "the amount of new material presented in a typical class is far more than a typical person can process or learn." That excess becomes all the more serious when one looks at summer-school classes. Teachers simply need more semesters over which to spread the work.

I disagree with many of the authors' other points, however. Not everyone will be able to learn the most intellectually challenging ideas. There are several important reasons why physics classes are small. First, not everyone is capable of doing physics. Second, in stark contrast to other difficult studies like medicine and law, the capitalist motivator isn't there: Physics doesn't pay well.

I don't favor using the Force Concepts Inventory the authors mention. It seems to me that traditional numerical problem solving more closely resembles how physics is really applied and used. Physics is highly mathematical, and that is not reflected in the FCI. Forces, for example, are vectorial in character. One needs to be able to handle vector addition and components. Also, some of the FCI questions would be best answered by direct experiment, not by discussion or human argument. When my students are asked how long two metal objects take to fall to the ground, I'd like to see them take two coins from their pocket and drop them next to the desk. I don't want to see students arguing how nature works. Experiment trumps argument. I don't see enough of an appeal to real experiment in Wieman and Perkins.

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If Carl Wieman and Katherine Perkins want to "change science education to make it effective and relevant for a much larger fraction of the student population," they will have to acknowledge—which like many physics education researchers they fail to do—that not all unhappy or unsuccessful physics students are alike. My analysis *They're Not Dumb, They're Different: Stalking the Second Tier* (Research Corp, 1990), derived from a decade of inquiry involving highly successful nonscience university faculty and graduate students, reveals a range of learning styles, interests, and anxieties about learning physics that are independent of intelligence and capacity for hard work. Some physics avoiders will no doubt respond to the authors' computer simulations. But some may not. Some underperformers will like discussion in groups; others may find it off-putting to have to talk about what one is not really sure of. So long as the physics-education community continues to seek a one-size-fits-all pedagogical solution to America's lagging production of physics majors, talent that is differently packaged from the norm will still be overlooked.

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The article by Carl Wieman and Katherine Perkins contains an unfortunate error with respect to radiation from violins. The correct multiple-choice answer to "The sound you hear from a violin is produced [by] . . ." is "(d) none of above."

Through the bridge, the string's motion drives the top plate. The top plate's motion is coupled to the back plate mainly through an internal cylindrical piece of wood, the sound post, which causes the back plate to move as well. That means both plates vibrate, thus both radiate. The violin is a complicated instrument, so it is not easily calculated which radiates more, the top or the back. In fact, the top plate is the stronger radiator. That has been empirically known for more than three centuries, and has been carefully measured by numerous researchers in the musical acoustics field in modern times. Makers pay particular attention to the fashioning of both plates to achieve the best relation between their normal modes.

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Wieman and Perkins reply: Robert Jones touches on many points in his letter. We claim some credibility as to "how physics is really applied and used," and we disagree with his opinion regarding the Force Concepts Inventory. We believe, and recent National Research Council reports reiterate, that conceptual reasoning, as tested by the FCI, is an important aspect of doing physics.

Jones's remaining statements about the proper ways to teach physics are a good example of the irony involved in many discussions about science education. Jones criticizes the research-based methods we discuss and advocates various alternatives, including students' carrying out certain experiments, by which he says they will better learn physics. However, he makes these claims of pedagogical superiority without any reference to data or even empirically established principles to support their validity. Science made dramatic progress once good data and well-tested theory became dominant over personal opinion and superstition. One of the primary points of our article is that a similar standard needs to be applied as to what constitutes a credible claim for science education, even in Kansas.

We believe that Sheila Tobias misinterpreted our article. In fact, we and the larger physics education research community are studying student differences and developing new teaching practices and learning tools that enable a variety of approaches to learning. Their effectiveness is tested with a broad range of students and generally increases learning of and interest in physics for a much larger percentage of the population.

Letters and opinions are encouraged and should be sent to Letters, PHYSICS TODAY, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842 or by e-mail to ptletter@aip.org (using your surname as "Subject"). Please include your affiliation, mailing address, and daytime phone number. We reserve the right to edit submissions.

