

Problem sets and other deterrents for women

James Trefil and Sarah Swartz, authors of "Problems with problem sets" (PHYSICS TODAY, November 2011, page 49), cite the approximately equal numbers of men and women in high school physics courses and the far fewer women than men who earn physics bachelor's degrees as evidence that "the root of the problem in physics lies in the undergraduate experience." I don't think that's at all clear from the evidence cited. The authors' interpretation assumes that equal numbers of women and men in high school courses indicate equal interests in pursuing physics degrees. That assumption is unjustified.

Students enroll in high school physics for a variety of reasons. In Texas, where I teach, physics is required for the courses of study followed by a large majority of Texas students. Even when physics courses are optional, as is the case with our second-year courses, students often sign up because they need them to get into a competitive college or because they want to study medicine, architecture, engineering, or some other major that requires physics and they want to start learning it in high school. The presence of those students may well mask a gender imbalance that already exists in high school or at the start of undergraduate studies. Indeed, according to the American Institute of Physics research that Trefil and Swartz cite, only 32% of high school students who sign up for AP physics are women. Thus much of the disparity is already evident before the physics students have opened their first college physics text.

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I teach my students that in order to solve a problem, you first must clearly identify it. In that spirit, I think more research is needed before we lay the blame on "the undergraduate experience."

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■ **Well done** to James Trefil and Sarah Swartz for raising the issue of the effect of problem wording and context on the performance of women in physics.

Laura McCullough (<http://uwstout.academia.edu/LauraMcCullough>) has done some interesting work in this area, too, including reworking questions on the force-concept inventory to bias them toward women. Women tend to prefer contexts that are beneficial to society, or at least nondestructive. In a high school textbook I coauthored, I modified the traditional plane-drops-a-bomb question to a plane drops a food-aid parcel. Small change, big effect. Furthermore, in my work with students from disadvantaged backgrounds, I find that issues that tend to affect predominantly women from advantaged communities also affect men from disadvantaged backgrounds. Presumably, that is at least in part because many of these students, male and female, lack exposure to the contexts and general knowledge assumed by textbook authors and instructors.

Swartz asked, "What is a banked curve?" I once wrote a question about a boy kicking a soccer ball into a pond for a class of South African students for whom English was the second language. Some students asked me, "What is a pond?" In South Africa, questions involving snow and icy roads are unimaginable. For children from deep rural areas, bungee jumping, spacecraft, and slam dunks are incomprehensible.

So-called context-rich questions often require students to read long sentences containing a great deal of explanation of the context. For speakers of English as a second language, such questions are harder than questions that are short, direct, and simply written. Students may fail because they cannot extract the physics from the lengthy

question statement. In a physics course I once taught for Zulu-speaking students, I devoted a whole class session to helping them do that extraction, with the assistance of an applied linguist. I am convinced that problem wording and context have a great influence on nontraditional students' willingness and ability to do physics.

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■ **James Trefil and Sarah Swartz** raise an important issue in physics education—the underrepresentation of women in physics. They particularly focus on the nonproportional decline of women—as compared with men—between high school physics and an undergraduate physics degree. In their article, Trefil and Swartz present important data clearly showing that the percentage of women in physics is particularly low; the authors argue that there is no obvious reason why physics should do worse than other fields, such as mathematics. They deduce from the data that the cause of the decline is women's undergraduate physics experience. Although the authors do not claim to have found a full explanation as to why the percentage of women declines so much, they hypothesize that gender bias in textbook problems might be a contributor—that is, that textbook problems assume prior knowledge more likely to be possessed by male than female students.

Unfortunately, the authors do not offer any research or data that support their hypothesis. That might have been fine for an opinion piece, but we are disappointed to see such extensive speculation in a PHYSICS TODAY article. Physics education research is not different from other research: Claims must be backed up with data and studies. Instead, Trefil and Swartz offer examples from unnamed sources—five from a "popular university physics text" and two from a "popular calculus textbook"—that are supposed to support their claims. Unfortunately, no study results are offered that would illuminate whether there are actually any gender differences in understand-

ing the examples, nor are we told how typical or widespread such examples are in textbooks.

The authors then partially contradict themselves by saying that “many young women do, in fact, have the kind of background needed to understand such problems ab initio.” The upbringing of the daughters of one author and their familiarity with chainsaws and other tools is offered as proof. Then we are told, again without data or references, that “a significant fraction of women, particularly those raised in urban or suburban environments, do not have that background.” The reader is left to wonder how young men would acquire their “special knowledge” in urban or suburban environments.

In our view, the authors draw a conclusion and make recommendations based on anecdotes and stereotypes. Without data on whether textbook problems require prior knowledge that places an asymmetric burden on women, one cannot know if their conclusion is correct. The article is simply a speculative opinion piece.

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■ In “Problems with problem sets,” authors James Trefil and Sarah Swartz use the word “problem” to refer to the fact that about 20% of physicists are women. Would they also call it a problem that less than 10% of nurses, elementary school teachers, and secretaries are men? Would they consider it good news if the percentage of men in those fields were to increase? Would they suggest that part of the reason for the underrepresentation of men might be that coursework for those professions includes problems that assume knowledge more likely possessed by women?

Of course the authors would never say that. In fact, it seems perfectly reasonable to just say that men are less interested in those professions than women are. Likewise, is it not also reasonable to assume that women are, on average, simply less interested in physics than men are?

At one point, Trefil says he tries to “be encouraging to his female students.” As opposed to what? Not en-

couraging his male students? The entire article was sexist.

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■ **The problem** James Trefil and Sarah Swartz address centers around learning the definitions of terms to which students, expressly female students in this case, might not previously have been exposed. Ignorance is no sin, but the definitions of “pile driver” and “I-beam” are readily found by asking a fellow student or referring to a dictionary. And exposing the real-world, everyday applications of physics concepts through problem sets is done not to confuse students but to illustrate the universality of the principles of physics. Trefil and Swartz have pitted themselves against authors who presumably selected or designed those problems not as impediments but as aids to learning basic physics. The success of one approach versus another rests to a large extent with the student.

Students today do not labor under the disadvantages that I faced in the 1930s and early 1940s. My Russian immigrant parents had no formal education and could offer no help with school work. Learning was fun for me, but I worked hard to achieve it. Textbooks then had few of the creative graphics and learning aids found in current ones.

But such aids are of little use if students, whether in K–12 or college, don’t or can’t use them. The problem, then, is learning how to learn before becoming irreversibly habituated to asking others or entirely dependent on the internet. As a substitute K–12 teacher for several years following my retirement, I devoted as much time and attention as my students tolerated to acquainting them with available resources and how to make the best use of them.

A student’s first exposure to an idea sets a long-lasting tone in the understanding and use of that idea. Early misconceptions can be difficult to dislodge, and the selection of problems and problem sets does well, along with lectures, to help ensure that such misconceptions do not take root. In light of that challenge, the use of unfamiliar terms that are readily found in dictionaries strikes me as a trivial impediment at most.

Teachers, though essential, best function as facilitators. Problem sets likewise serve as facilitators. The major part of the learning process resides in the students, male or female. Help them by all means. Understand—and, if necessary, help them

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