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.

Sarah Gilbert
Cynthia Heiner
Natasha Holmes
Ido Roll
Georg Rieger
(rieger@phas.ubc.ca)
Ashley Welsh
Carl Wieman Science Education Initiative
University of British Columbia
Vancouver, Canada

■ **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 encouraging his male students? The entire article was sexist.

Jeffery Winkler
(jefferywinkler@mail.com)
Hanford, California

■ **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 unlearn—their home-, school-, and street-derived intellectual baggage. But, with due allowance for special circumstances, do not relieve them, especially those in higher education, of responsibility for their own education.

I have no definitive answer for whether the points I raise here relate to the dearth of female bachelor-level physicists. Whatever the causes of the gender gap among undergraduate physics majors may be, I wish the physics community well in narrowing it.

Manuel N. Bass
Fullerton, California

■ **Trefil and Swartz reply:** We thank our colleagues for contributing to this important debate. Diane Grayson added an international perspective, and Manuel Bass deepened our insights into the role of problem sets in science education.

Mark Lesmeister argues that the underrepresentation of women in physics may begin before college. Regardless of whether that is true, the data in figure 2 of our article clearly show a rapid decline in female participation during the undergraduate years. That is the problem we chose to address.

Sarah Gilbert and coauthors point out that there is ample room for more research in this area, and we agree. We think, however, that studies cited in our article amply support the modest conclusions we draw. We hope that the article will help to stimulate the type of research Gilbert and coauthors think is needed.

Jeffery Winkler presents a variation on the old argument that women just don't like physics. If that were true, we would have trouble understanding the success of fields like mathematics and chemistry in attracting women. Nevertheless, it is worthwhile to consider whether there may be unnecessary deterrents to students' staying in physics, particularly if the deterrents could be easily fixed.

James Trefil
(jtrefil@gmu.edu)
Sarah Swartz
George Mason University
Fairfax, Virginia

On the value of particle physics

The naive letter by John Waymouth (PHYSICS TODAY, September 2011, page 10) claims that particle physics has never "produced permanent jobs for anyone except high-energy physicists and their acolytes and assistants."

My group at Vanderbilt University designed and built high-field magnets to measure the Σ hyperon's magnetic moment in experiments at Caltech and at Brookhaven National Laboratory. Using those magnets and teaming up with Oak Ridge National Laboratory, we were able to demonstrate the superconductivity of niobium–tin at fields of up to 14 T, which was 6 T higher than had been previously observed.

Several of my students made careers in applied superconductivity. For example, A. D. McInturff has designed superconducting magnets at Brookhaven, Fermilab, and CERN; his PhD thesis included the first measurement of the Σ hyperon's magnetic moment. A magnet-stabilization technique that he first suggested has transformed medical practice.

Rapid communication between experimental groups was very expensive when I worked at CERN. A group led by Tim Berners-Lee in the computer division developed the Hypertext Transfer Protocol, which is used to modify networks to provide inexpensive, rapid internet communication.

The recent detection of the Ξ_b^- decays[1] may be of limited public interest, but the ability to data-mine 500 trillion collisions and find the 25 candidates is important in many areas. There is no shortage of jobs for anyone with the ability to select the significant information from the vast flood of raw data available today.

My retirement project uses computer and sensor technologies developed for particle physics to make industrial sorting machines. These machines identify and sort post-consumer PET (polyethylene terephthalate) beverage bottles in Asia, Australia, Europe, and North and South America. Recycled PET is made into new bottles or polyester fiber used in clothing and carpets.

Particle physics is a major source of innovation and economic growth in areas as diverse as medicine, recycling, data management, and the internet. I do not know if the Higgs particle exists, but I am confident that future jobs and technologies will result from the efforts to find it.

Reference

1. V. M. Abazov et al. (D0 collaboration), *Phys. Rev. Lett.* **99**, 052001 (2007).

Charles E. Roos
(nrtinfo@nrtsorters.com)
Vanderbilt University
Nashville, Tennessee

Notes on Anderson localization

Ad Lagendijk, Bart van Tiggelen, and Diederik Wiersma, in their article "Fifty years of Anderson localization" (PHYSICS TODAY, August 2009, page 24), discuss the experimental studies in semiconductors such as weakly compensated phosphorus-doped silicon. However, the authors don't accurately depict the situation, and they ignore important work.

Lagendijk and coauthors note that in 1982 a Bell Labs group[1] found that for charge-carrier densities n above a critical value n_c in weakly compensated Si:P, the conductivity, extrapolated to zero temperature, scaled with reduced density with an exponent s of approximately 0.5; for compensated semiconductors (also amorphous alloys), experiments yielded s of approximately 1, which agrees with the scaling theory. As the authors describe, that finding led to the "exponent puzzle." But the zero-compensation case includes only off-diagonal order in contrast to the 1958 paper by Philip Anderson. The different disorder cases are characterized by different scaling exponents.

Considerable controversy ensued in 1993–99. H. Stupp at Karlsruhe University and coauthors[2] claimed an exponent of 1.3 for Si:P, but with n_c 6% lower than the Bell group. I showed that for n between 3.52×10^{18} cm^{-3} and 3.69×10^{18} cm^{-3}, the data were a better fit to Mott variable-range hopping; the finding suggests that these samples were insulating as $T \to 0$. A 6% decrease in n_c increased s from 0.5 to 1.3, which demonstrates the very strong coupling between s and n_c. Lagendijk and coauthors state, without giving references, "In 1999, researchers argued that an exponent of 1 is recovered in the experiments on silicon if the conductivity is correctly extrapolated to zero temperature." That statement is misleading. In 1999 two groups[3] reported measurements of σ as a function of uniaxial stress on Si:B and Si:P. Both groups observed a substantial increase in s from near 0.5 to between 1.2 and 1.5 close to n_c. However, compressive uniaxial stress introduces inhomogeneity from sample bending, which increases s.[4] The features of the 1999 data were similar to the Bell Si:P data, but the Bell group didn't analyze the tail portion of its data very close to n_c where the stress inhomogeneity became dominant and σ is small.

Are features like weak localization or carrier interactions relevant or es-