

out and leave the discussion to biologists, and that scientists have a faith of their own. The first is asserted without explanation and the second seems curious in light of the first. Schofield's third point is interesting. I think most scientists take on faith that there is some understandable pattern to the things we can observe, that we are on the right track in investigating that pattern by the methods of science, and that we are closing in on something that corresponds to our intuitive idea of reality. That belief is a matter of our meta-science, or perhaps of our psychology, not part of the science itself, which deals only with the observable world. The important thing for the present discussion is that this belief neither confirms nor contradicts religion.

Michael Todhunter asks to debate the evidence for evolution in the fossil record. Books have been written on that subject—I cited two in my Opinion piece. The practical political issue is this: What should our public schools teach when confronted with disagreements they are not themselves able to resolve? The answer is easy. Almost all the most respected biologists are saying that evolution is the theory that works and that it is the central organizing principle of modern biology. If the school boards have any sense, that is what their schools will teach despite a few dissenters, some of whom offer genuine scientific challenges to the theory and most of whom have other agendas. The schools should be teaching their students that all theories have wrinkles that remain to be ironed out. They should be teaching that all theories are tentative and our understanding is always incomplete, but that science progresses by building on what we know best. Well-established theories such as evolution work too well not to have mostly permanent truth in them, even though the theories will evolve in response to new evidence. We should be helping the school boards by educating their constituents.

Contrary to Schofield's advice, all kinds of scientists should be explaining to the public what science is about and emphasizing its strengths and its limitations, because the public and not the courts will decide where this country will go in the 21st century.

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US lacks nuclear-power infrastructure

I read with great interest the hopeful items about the coming nuclear power boom (PHYSICS TODAY, February 2006, pages 11 and 19), but I would like to point out that the US has lost the infrastructure to build these plants. Because of economics, the US no longer has the heavy industry capable of building the reactor heads and steam generators that new plants require. Reactor owners looking to replace aging plant components must contract with Japanese, Korean, or Italian companies for the heavy forging and machine work that was once done in America, and compete against other interests for both valuable plant time and floor space to get their components finished. American nuclear plants are just not a 600-pound gorilla that can command the marketplace anymore.

America is also losing the quality battle for smaller components such as pumps, valves, and circuit breakers. Many of the smaller vendors and foundries that once produced pumps, piping, and valves to the ASME Boiler and Pressure Vessel Code (a nuclear requirement) have been swallowed up by mergers, leaving only a few suppliers. And those few have had little incentive to keep a costly quality program that meets the requirements of a nuclear supplier as defined in the Code of Federal Regulations (10CFR50, appendix B) because the market for nuclear replacement parts is scant. Other suppliers have lost control of their quality programs because of such factors as off-shore production and the loss of tribal knowledge due to an aging workforce and downsizing.

This isn't to say that America won't produce new nuclear power generating stations, but a lot of infrastructure investment will be needed to bring the US back to the level where we can make them using American resources and labor.

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Training teachers for college

I have enjoyed the articles about physics education that have appeared in the past several months. They have generated a great deal of knowledge that needs to be integrated into educa-

tional programs at all levels. However, I have noticed that much of the discussion about training has focused on K–12 teachers, who are trained in the baccalaureate education programs of colleges and universities. This focus is important, but it avoids a long-standing problem: how to train college and university professors.

Professors are rarely required to have taken education courses, yet they must usually demonstrate a dedication to teaching and state some philosophy of teaching. A prospective professor's approach to teaching must apparently be developed independently. Most physics professors have developed their approaches to teaching through their experiences as graduate students and postdocs.

I believe that current and prospective professors would be well served by a series of courses or training sessions, implemented at many colleges and universities worldwide, that distill current physics education knowledge and provide a venue for practicing it with other students. The courses could be offered as part of undergraduate or graduate curricula or in pre-employment or professional-development training sessions. Alternatively, training sessions could be implemented as an ongoing part of the annual conferences of the various scientific professional societies, and then funding could be secured for conference attendees. (This approach could also work for K–12 teachers.) Implementation of training courses would be helpful not only to current professors but also to those who, like me, are employed in industry but would eventually like a teaching career.

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Diverse thoughts on diversity in physics

I read Shirley Malcom's "Diversity in Physics" article (PHYSICS TODAY, June 2006, page 44) with great interest. As a physics student in college, I often marveled at just how white and male all of my classmates and professors were.

I have been teaching physics for four years in a public high school in Massachusetts, and I think I can address at least one piece of the puzzle. In my first year as a teacher, I made the classic novice error of teaching as I had

learned. Apparently, this method worked great with the boys, but not so well with the girls. The disparity bothered me, since it was clear to me that the female students were more mature, just as well prepared, and as capable as the male students. Over time I observed that the boys were not very careful about the intermediate steps in their work and often rushed to a solution that they found reasonable. This brazen fearlessness benefited them, as they would often receive partial credit for sloppy work on their way to the correct final answer.

In my second year, I made a conscientious effort to teach good problem-solving techniques and to outline general methodologies for broad classes of physics problems. I found that the female students rose to the head of the class, and they have remained there ever since. My explanation, based on my experience, is that boys are trained by society to be fearless and aggressive, which empowers them to dive toward a solution even without a clear idea of what they are doing. Girls, on the other hand, frequently want to know where they are going before they start out on a physics journey. I believe that the emotive aspects of teenage boys and girls come into play in physics problem solving and reasoning.

The solution? More female high-school physics teachers will surely help, but in the meantime, let's train the male teachers to break problems down, elucidate the steps, and make sure they are talking to everyone in the class, not just to the ones that respond to problems the same way they do. By following these methods myself, I believe I have become a better teacher for all my students, not just the girls.

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Shirley Malcom's article begins by assuming that the US physics community should reflect the diversity of our nation. This assumption is not self-evident. To my knowledge, no one is excluded from studying physics.

I believe that physics could be better taught in primary and secondary schools, but that is not a problem of race or gender. My children attended public schools in the Maryland suburbs of Washington, DC, and their classes were predominantly white and middle class. But the high-school physics teacher was pathetic.

Malcom's article does say that 65% of undergraduates are female or "under-represented minorities." If we apply her argument that the low percentage of underrepresented minorities is undesirable on its face, we should be selectively encouraging white males to go to college.

I believe the problems with our school system include teachers who are certified without being trained in the subjects they teach and curricula that do not require all students to study science, real literature, and other fundamental elements of literacy.

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Before declaring a call to arms in the name of diversity, it would be prudent to briefly evaluate whether the ends justify the means. Shirley Malcom cites statistics illustrating the gender and racial disparities in physics to support her disapproval of the scales being tipped in favor of the white male. After presenting her case, she sets forth a possible course of action—the use of preferential treatment toward women and minorities; she contends that such a policy will end the injustice.

On the surface, this aggressive policy to recruit minority members into physics may seem like a good idea; it would appear necessary, given the inequality of representation with regard to men and women and to Caucasians and minorities. However, the issue is surely not as straightforward and easily rectified as Malcom suggests.

First, her initial imperative that women and minorities be represented in numbers "commensurate with their proportions in the general population" is naive. Given the variability of cultures and individual histories, it would seem natural that various segments of the population might be geared to pursue certain disciplines over others.

Second, many high schools around the nation do not require that students take a course in physics. I attended high school in Missouri, which required courses in biology and chemistry; physics was an elective. In light of the lack of a physics requirement, comparing the number of high-school students who took physics with those who took other sciences essentially constructs a straw man, strips the percentages of their context, and omits relevant factors. And further, physics may very well be one of the most difficult disci-

plines to study, possibly more demanding both conceptually and analytically than any other science; thus, more individuals are apt to pursue study in the other spheres of science.

Third, I have seen no substantiation for the idea that actively recruiting women and minorities into physics—at least by the method Malcom proposes—would be beneficial to the overall health of the discipline. In essence, this is the quality versus equality debate that has plagued affirmative action programs since their inception. Should her proposal be taken at face value, it would hardly be good for the advancement of the physics community. It would sacrifice quality of members for the end goal of diversity in the guise of proportional representation. The solution to the problem of integrating women and minority members into physics is not, and should not be, diversity for diversity's sake. Rather, the best solutions are educational outreach programs such as those already initiated by universities in primary and secondary schools across the nation and an overhaul of the family and traditional cultural norms that pervade and further embed the current stereotypes and injustices. The programs should not be directed toward only women and minorities, and institutions should not be rewarded for being preferential in their offering of these programs—such a practice can only hurt the study of physics. In fact, the inclusion of race or gender in any matter does nothing to alleviate supposed injustices, but instead hinders the goal of one day achieving a truly gender-free and colorblind society.

So indeed, as Malcom says, "failing to consider change is unacceptable to the health of the field." But the solutions she puts forth are equally unacceptable. Should those in positions of power feel inspired to work for the betterment of mankind, they would do well to realize that the ends often do not justify the means.

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Malcom replies: Ken Rideout has made some perceptive comments in his letter: The initial tendency for most of us who serve as faculty is to teach as we are taught. He recognized that in doing so, he was rewarding poor problem-solving techniques, thus hurting all students, the female students who were frustrated and the male students whose