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 "underrepresented 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 disciplines 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

bad habits were reinforced. There is no substitute for good teaching, no matter the sex of the teacher. Would that other faculty were similarly concerned when otherwise intelligent people are unsuccessful in their classes. But the tendency in education all too often is to blame the students rather than also to consider the quality of instruction.

Nicholas Nicholas misreads my intent. Taken a different way, when a field looks so *unlike* the population of students from which it draws, the field itself needs to consider where problems might lie. My children also attended Maryland suburban high schools; both daughters took physics. Fortunately, the teacher was good, and both emerged still liking physics, though the liking expressed itself in different directions. I concur that bad teaching can kill interest of all but the most determined students. I do not argue for proportional representation. Yet I wonder, as white males' proportion of the overall student population dwindles, will physics shrink into a smaller pool, fated to see continued decline? Or will the discipline try to access talent in untapped pools by actually competing for it?

In many historically black colleges and universities, the number of African American physics majors is increasing. Other countries have higher participation of women in physics than the US. Women receive more than 25% of the physics PhDs in Turkey and France, for example, compared with around 15% in this country. What do they know that we don't know? And what do they do that we don't do?

Kristofer Gryte also misreads my intent. I believe that the current structure of physics education and of the physics community has created the field's demographics. It is hard to argue that some populations "might be geared"—a euphemism indeed—toward physics when they do not have full opportunity to explore the possibilities, to study, to experience, and to consider careers in physics-related fields. Such euphemisms suggest predispositions (nature) that don't reside in the gene pool. Rather they emerge through teaching and learning (nurture) that supports the curiosity in all of us about how our world works.

I will not take on the larger issue of "field chauvinism," since I believe that many concepts in physics are exceedingly accessible, even to young children.

We need to go after the problem areas. I do not think physics should be a high-school elective. I agree with Nobel laureate Leon Lederman that it should probably be the first high-school science course and that the teaching of physics concepts should begin in prekindergarten.

Gryte mistakenly pits equity against excellence. Gender-free and colorblind considerations can only be achieved by first taking both gender and color into account. Excellence and equity are inextricably linked; they rise and fall together no matter how much we wish it otherwise. If they fall, physics—and the publics it serves—loses.

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Points or knobs on lightning rods

I offer an addendum to Philip Krider's article "Benjamin Franklin and Lightning Rods" (PHYSICS TODAY, January 2006, page 42). The science historian J. D. Bernal wrote the following:[1]

In 1780, Franklin's patriotic, or rebel, tendencies led King George III to insist that the lightning conductors at Kew Palace (near London) should have round knobs instead of Franklin's recommended sharp points.

A contemporary wit wrote,

"While you, great George, for safety hunt,
And sharp conductors change for blunt,
The nation's out of joint.

Franklin a wiser course pursues,
And all your thunder fearless views,
By keeping to the point."

Sir John Pringle (1707–82), the President of the Royal Society, could not agree to the knobs and was induced to resign his Presidency.

Reference

1. Quoted material is abridged from J. D. Bernal, *Science in History*, Penguin Books, Harmondsworth, UK (1969).

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