They're Not Dumb, They're Different: Stalking the Second Tier

Sheila Tobias
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Some college students seem bent upon studying or even majoring in physical science. However, a "second tier" of students begin with apparent interest in science but eventually drop out of science courses, developing perhaps a lasting phobia or antipathy toward physical science. This prompts two questions: Why do these students "leak out of the science pipeline"; and why should we care? In her new book Sheila Tobias deals briefly with the second question, citing projections of personnel shortfalls in the physical sciences as justification that a problem exists. Her main emphasis is on the first question—and she suggests that understanding and solving the first problem may go a long way in helping to solve the manpower problem.

Tobias rejects one easy answer—that physical science dropouts are incapable of competing in the field; she notes that we are in fact losing bright, high-achieving students with strong high school backgrounds in math and physical science. This book focuses on what Tobias feels is both a critical loss point and the point where college science teachers have the greatest impact in either attracting or turning off students: the introductory physics or chemistry course.

Starting with this premise, she conducted a study to determine which aspects of the culture and content of physics and chemistry courses turn off talented students. In terms of content, the study found several problems with the physics courses: They lacked a narrative thread; they had exams that were too easy and homework that was too hard; they emphasized problem solving to the exclusion of contextual, historical and conceptual material; and they presented too much material at too great a pace. The study also found major problems with the culture of physics courses: The lecture format discouraged active learning and reinforced students' tendency toward boredom and passivity produced by course's content; no sense of community was generated in the classroom—the teacher was unconnected to the students and they were unconnected to each other; and the atmosphere was obsessively competitive with an emphasis on grades.

Tobias's arguments and conclusions are compelling (and many of them do feel "right" to me). However, the methodology of the study and statistical validity of the results are open to question. The study used paid "observers" who in the calculus-based physics course, for example, were expected to do all the homework and take all the hour exams while carefully recording their personal and intellectual responses to the course. The observers did not participate in the labs accompanying the physics courses—a serious flaw in methodology. The physics observers were three graduate students and one faculty member, all from nonscience disciplines in two large state universities. This population sample is both very limited and quite different from the population of interest—science-oriented freshmen.

Tobias augmented her results with the Lipson study, which extracted some new data from The Concentration Choice Study, a longitudinal study done at Harvard–Radcliffe covering the years 1973–83. The original study was based on periodic surveys over the four-year college career of a larger sample (300 students) from a more relevant population; the newly extracted data support some of Tobias's conclusions.

A final quibble is that Tobias does not cite important existing work. The physics community has recognized both the central role of and the need for change in the introductory physics course. Work in this area ranges from the Introductory University Physics Project, to the lab-based course developed by Ronald Thornton, Priscilla Laws and David Sokoloff, to papers on the problem of "community" in the physics classroom.

Tobias's book is a useful and practical-minded addition to the literature dealing with the ongoing concern about science education and scientific literacy in the US: The book deserves to be read by anyone interested in the future of science and should spark further studies. I hope this type of work continues; however, it would be nice to see it jusitfied more by the intrinsic worth of physics than by the use of notoriously inaccurate and fickle manpower projections. For example, we could work toward three interrelated goals: to extend the possibility of majoring in physics to a broader range of students; to move toward a notion of "professional physicist" as a human being rather than "professional physicist" as high priest; and to encourage more students to pursue a minor in physics thereby produce greater physics literacy in the general population. It is exciting to contemplate what would happen if some real understanding and love of physics were instilled in our politicians, lawyers and medical doctors.

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The Fifth Branch: Science Advisors as Policymakers

Sheila Jasanoff
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Sheila Jasanoff is director of Cornell University's Program on Science, Technology and Society. In this book her main concern is how the "fourth branch" of the Federal government—the regulatory agencies—can best use the "fifth branch"—science advisors—to make decisions that will survive challenges from the executive, legislative and judicial branches. She discusses mainly the science advisory experiences of the Environmental Protection Agency and the Food and Drug Administration during the 1980s, although she draws conclusions of more general interest.

The FDA gives advisory committees broad responsibilities, from performing literature reviews to recommending policy, but it reserves the right to overrule such policy recommendations. The EPA, on the other hand, prefers a more adversarial relationship with its advisory committees, which review policies that the EPA staff has proposed. Jasanoff argues that the FDA model works better, because it gives the scientific advisers more latitude to resolve disputes and build consensus by informal negotiation.

The difficulties raised by the EPA's adversarial approach are illustrated by its actions regarding the plant-growth regulator Alar. In 1985 EPA proposed a ban on Alar on the basis of several experiments indicating that it caused cancer in laboratory animals. The proposed ban was then reviewed by the EPA Scientific Advisory Panel, a legislatively mandated body whose members are selected by the EPA administrator from nominations submitted by NSF and NIH. The presentation before the panel pitted EPA staff against experts representing Alar's manufacturer, Uniroyal. The Uniroyal experts attempted to discredit each of the Alar studies individually, but EPA scientists pointed to the coherence of the data as a whole. When the panel sided with Uniroyal despite strong protests from top EPA