

# Is Physics Difficult?\*

Kenneth W. Ford

First, a fable:

Dean Hugh Manatee of West Nonesuch State has been concerned because his English Department is attracting so few majors. The Chair of the department responds to the Dean.

To: Dean Mantee

From: Shirley Worde-Smith

Subject: The English Major

The English Department would be pleased if more students capable of succeeding in English chose to major in this subject but, as you know, English is quite difficult. Only a small percentage of students exhibits aptitude for writing—the experimental part of our discipline—and talent in literary theory is even rarer. However, we had 5 English majors among last year's graduating class of 1,043. This is well above the national norm of 3 per 1,000. We are fortunate in being able to attract excellent students to our demanding program.

Studies by the American Institute of English show that the supply and demand for professional writers and literary critics are now in balance in this country. It is not clear how our graduates would find meaningful professional employment if their numbers were to grow significantly. We do feel that our graduates in English have a very strong training, which is borne out by the fact that most of them readily find employment or gain admission to excellent graduate schools.

As to our service obligations, we are anxious to do our part to meet the wider needs of the University and its students. It is for this reason that we recently introduced an "English for Poets" course to allow a broader range of students to gain an appreciation of what research and creative effort in English are all about. The student response has been gratifying. So much so, that we are considering the addition next year of another terminal course, "English and Society."

Let me next address the nature of English teaching. Through regular lecture demonstrations, we expose students di-

rectly to good writing and criticism. And in the English laboratory, students gain hands-on experience in actual writing. These features of the discipline mean that teaching English is intrinsically labor intensive. A program of the excellence of ours cannot be maintained if professors are expected to meet teaching-load requirements typical of other departments.

If the English department lowered its standards in order to attract more majors, we would seriously erode the quality of our program, faculty research would be adversely affected, and we would be turning out graduates of doubtful skill whose prospects of employment as practitioners of English would be in question. We would not be serving the national interest or the interest of Nonesuch.

The dean's response is not preserved.

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I agree.

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Allan Feldman, who teaches physics at Germantown Friends School in Philadelphia, recently wrote, in an article on his school's physics program: "Physics is not easy, and a course that pretends to be so is not honest to the student." This is a short, clear statement of an opinion probably held by most physics teachers. But what does "Physics is not easy" mean? If it means that most students who study physics find it difficult, I agree. If it means—as many physicists believe—that our discipline is intrinsically more difficult than others, I do not agree.

Physics is difficult in the same way that all serious intellectual effort is difficult. Solid understanding of English literature, or economics, or history, or music, or biology—or physics—does not come without hard work. But we typically act on the assumption (and argue to our principals and deans) that ours is a discipline more demanding than almost all others, a disci-

pline that only a few are capable of comprehending.

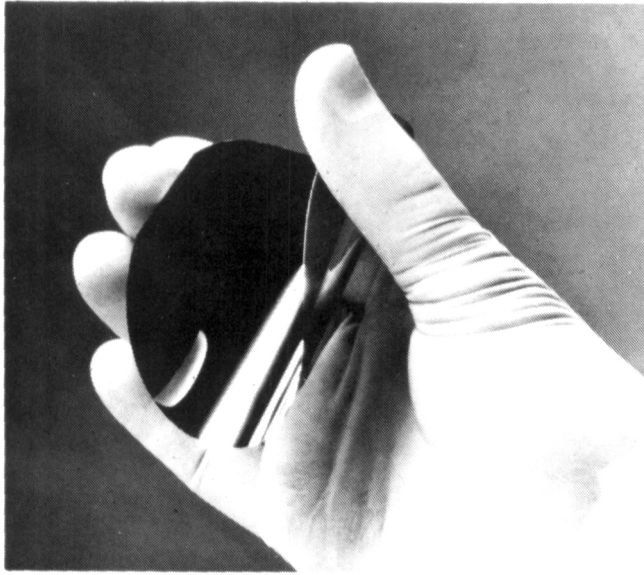
The priesthood syndrome that flows from this assumption is, regrettably, seductive. If you are a high-school or college physics teacher, how could it not give you a warm glow to know that your colleagues in other fields stand in awe of your intellect? You are master of knowledge that lies forever beyond their reach. If someone you have just met says, "What do you do?" and you answer, "I am a physicist," do you not await, with pleasant anticipation, a standard response such as "Gosh, you must be smart!?" (It is a common joke that the surgeon, making small talk before the operation, says to his physicist patient, "I nearly flunked physics. It was beyond me!")

We have, indeed, been so successful in selling ourselves as masters of occult knowledge that the average person, if confused by a physicist's explanation, blames himself or herself for deficient brainpower, not the physicist for deficient pedagogic skill. In the *Washington Post* of December 2, 1988 (p. A27), Charles Krauthammer, writing about Stephen Hawking's *A Brief History of Time*, says: "If given enough attention, every sentence makes sense. But when you have registered all the sentences, you realize in the end that you understand nothing. It is not Mr. Hawking that is beyond comprehension, but modern physics." Mr. Krauthammer writes himself off. Modern physics is beyond the comprehension, he implies, of all but the physics priesthood. He does not ask whether the fault for the failure of communication might lie with the writer (a physicist), not with the reader.

If physics is not more difficult than other disciplines, why does everyone think that it is? To answer indirectly, let me turn again to English. Six-year-olds write English and (to pick a skilled physicist writer) Jeremy Bernstein writes English. What separates them? A long, gradual incline of increased ability, understanding, and practice. Some few people, illiterates, do not start up the hill. Most people climb some distance. A few climb as far as Bernstein. For physics, on the other hand, we have fashioned a cliff. There is no gradual ramp, only a near-vertical ascent to its high plateau. When the cliff is encountered for the first time by 16- or 17-year-olds, it is small wonder that only a few have the courage (and the skill) to climb it. There is no good reason for this difference of intellectual topography. First-graders could be taught some physics, second-graders a little more, and third-graders more still. Then, for the eleventh- or twelfth-grader, a physics course would be a manageable step upward. Some

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might choose to take it, some not, but few would be barred by lack of "talent" or background.

Can "real" physics be taught to children? If you prefer, call physics for children "pre-physics." The point is that the cliff of physics is of our own making. It is not intrinsic. It seems unscalable to most because we have failed to provide any gradual path to its top.

The absence of a learning ramp in elementary and middle school is only part of the reason that physics has become a priestly lore. We must also examine our convictions about who should learn physics and why. Physicists commonly believe that physics (beyond the freshman level) should be studied only by people intending to become practicing professional physicists. As the parody at the beginning of this essay suggests, college and university education would be in a bad way if our colleagues in other departments held the same view. Fortunately, most other departments offer majors for "average" students, not just for those who are destined to provide future creative talent in the various disciplines.

We in physics are caught in a negative feedback loop. Because we regard our subject as being unusually difficult, we expect only the most talented to study it. Because we do attract highly talented students, we can make our curriculum difficult enough that it is closed off to students of average ability. Then everyone joins in our assessment of the difficulty of physics.

Physics—*real* physics—can be taught at many levels. There are, to be sure, many good reasons why it will not be easy to attract a broader range of students to physics. Adding new courses strains faculty resources. Students will not easily be convinced that surviving (or enjoying) a physics major is possible. And there is the very real problem that students arriving at the door of the physics classroom, be it in high school or college, are indeed less well prepared for a serious study of the subject than they are at most other classroom doors. Yet, if our discipline is to prosper and if we are to help contribute to a more informed citizenry, we must shed the priesthood syndrome, recognize that there are meaningful ways to teach physics to "ordinary" people, and work at attracting larger numbers of students to physics.

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