

his use of the term "evolve" in this context suggests that he may be giving insufficient weight to the difficulties confronting macroevolutionary theories today.¹

References

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Plaudits for PSSC Physics

I had not intended to write in regard to the article "Setting New Directions in Physics Teaching: PSSC 30 Years Later" by Anthony French (September 1986, page 30), since I felt it was so well and accurately done. However, I was very disappointed with the response exemplified by the letters published in the April 1987 issue, and I feel compelled to comment. None of the respondents whose comments were published were clearly identified as high-school teachers who had taught the PSSC course and had the opportunity to compare it with other physics courses they had taught. David S. Martin explained why he had chosen not to teach the PSSC course, though he indicated that he made use of the PSSC labs and films. His statement regarding the lack of involvement of high-school teachers does not match either the facts or my personal experiences as one of the first PSSC teachers. During the early years, we could hardly have been more involved! We were asked to evaluate the lab materials and instructions, the text materials, the problems, the tests and the films. Our evaluations included specific student responses to and difficulties with individual problems, test items, paragraphs and even sentences from the text. We saw the changes we recommended appear in later versions of the lab guides, text, tests, problems and in the teacher's guides. Over 600 high-school teachers and over 25 000 high-school students participated in the evaluation of the materials during the first three test years.

Our school was also involved in evaluation of the PSSC films, and as

early as 1960 student comments included references to widths of neckties and Eric Rogers's glasses being removed and replaced a number of times. As French suggested in his article, the primary criticisms of my present students do include haircuts and awareness of lapel widths, and the copyright date at the beginning of each film is a major distractor. At the same time, the students are aware that in space travel, as the astronauts stated, Isaac Newton still "does most of the driving"—and his film would have a copyright date nearly 300 years old.

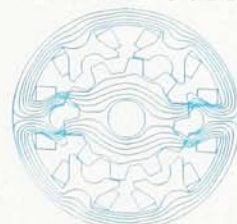
I started teaching physics in 1949, and I was quite frustrated with the physics texts, labs and supportive materials available. The topics were segmented and highly application oriented. There seemed to be no clear attempt to help a student (or teacher) answer or even ask the question "How do we know?" I was most frustrated with the lack of any overall picture of the fundamental principles and processes of physics. My own background was limited (a major in mathematics and minors in physics and philosophy), and I knew I was poorly qualified to make basic judgments about what was fundamental and what was extra. (Too many in similar situations readily criticize available materials and then "develop their own courses." The result *cannot* be better than the limited background and special interests of the developer.)

In the summer of 1958 I participated in the first PSSC Institute at Reed College, and I found much more than I had expected. Labs had been developed in which the apparatus did not obscure the principle, process or relation they were trying to clarify. "How do we know?" and "What are the limitations of our conclusions?" were the essence. The laboratory was the basic place where information was obtained, and the text was a reference source. In the institutes, PSSC teachers had the opportunity to learn why the content choices were made, and how the pieces all fit together. They learned that the text is not the "bible," and that the concept of physics as an "exact science" is at best misleading. Teachers had an opportunity to learn physics as a way of thinking, and not as an application of memorized, mechanical rules for solving problems, and were prepared to help their students do the same thing.

My comments in regard to PSSC Physics are based on 29 years of feedback from former PSSC students who are now scientists, engineers, doctors, lawyers and architects as well as accountants, businessmen

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and women, and men and women engaged in occupations not directly associated with science. I have received as many favorable comments from one group as the other. Though the nonscientists have forgotten many of the specifics of physics, they value and remember the PSSC training they received in critical thinking, problem solving and in understanding and appreciating how scientists have tried to understand the universe and the fundamental laws by which it operates.

Many high-school physics teachers claim that they teach "critical thinking," but learning to do critical and quantitative thinking involves some honest and sustained effort. Not everyone is willing to expend such effort, and the PSSC course has required somewhat more rigorous commitment than many other courses called physics. While there has recently been some reaffirmation of the work ethic, in the late 1960s and early 1970s it was less highly regarded by students. Someday it may be possible to determine the degree to which the attitudinal changes of students were a major factor in decreasing enrollments in physics, as opposed to PSSC Physics as the cause. When students adopted the "me-now" attitude, and the work ethic was not highly valued, a course with rigor was less highly sought after.

During this same period there was considerable unrest, protest and diversion of attention from academics. The number of athletic opportunities available to students nearly doubled in most schools, as girls' athletics programs were added. This called for many more teacher-coaches than ever before, and teachers had to be even more "generalists" than before, with increasing demands on their preparation time. The NSF-sponsored institutes disappeared, and highly qualified teachers of physics were not in abundance among college graduates. What then are the primary causes of low enrollment in physics courses around the country?

Since the mid-1960s we have used in addition to PSSC the "Advanced Topics, PSSC" materials in our second-year physics-chemistry course. In the early 1970s I introduced and taught the Harvard Project Physics course as an alternative physics course for students whose goals were directed toward nonscience careers. Our physics enrollment has not decreased. It was increased by the Project Physics Course. We also work cooperatively with our counselors, which is not always the case. We have over 200 students enrolled in our

physics courses this next year, in a high school of less than 1400. I have no doubt that my association with PSSC Physics has made me a better teacher than I would otherwise have been, and my students have received better training than I think they would otherwise have gotten from me.

I think that the PSSC effort represents one of the most outstanding cooperative efforts ever conducted in education. Much more PSSC-influenced physics is being taught in today's high schools than the statistics show. Textbooks after the PSSC suddenly began to show up with ripple tank photographs, "slinky" spring wave studies, strobe photographs and clearer emphasis on the power of graphical analysis of data. Simpler lab experiments, more clearly directed at basic principles, began to appear in these non-PSSC lab guides. I doubt that there are many high-school physics courses that were not altered to their benefit by the PSSC effort. Later national endeavors certainly noted and made use of the methods of the Physical Science Study Committee and the feedback from those who were testing the program. Some teachers who claim to be critical of the PSSC program admit that they borrow liberally from the labs and still use the films.

The AAAS elementary science program "Science, A Process Approach" died out; yet it could have trained nearly all elementary-school students in critical and scientific thinking. Was it because it was inappropriate for the students, or for the teachers? Think what we might have had by now if many elementary teachers could teach their students the attitudes and skills of the AAAS program, and we would get those students in PSSC-type physics courses in high school. Would the PSSC course then be inappropriate for our "average" students?

I applaud the current efforts of the NSF as it directs its attention toward the scientific retraining (initial training?) of elementary teachers—especially where such efforts involve college professors of physics and education collaborating with outstanding elementary teachers. I also applaud those "ivory tower physicists" who 30 years ago worked so hard and so long in their successful effort to improve high-school physics teaching. I am grateful to Uri Haber-Schaim, the original PSSC member who has kept the PSSC materials available and up to date.

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