The Myth of Scientific Literacy by Morris H. Shamos. New Brunswick, N.J.: Rutgers University Press, 1995, 261 pp. ISBN 0-8135-2196-3, $27.95.

Physicist Morris Shamos has written a book which will sadden any who hope the public will soon become "scientifically literate." He brings a broad perspective to his writing: physicist at NYU, teacher at elementary through graduate school levels, director of a national elementary school curriculum development program, and industrial scientist. This gives weight to his conclusion that none of the initiatives in curriculum and instruction presently under way will have any more success than their predecessors. Shamos ends with a proposal for a new attempt to achieve a modified goal.

The book begins by examining claims of a crisis in science education, pointing out that earlier fears of a shortage of scientists and engineers have not been justified. The quality of those scientists and engineers remains high. Thus, the only crisis relates to science education for the general public.

The goal for the general public is often termed "scientific literacy." In his second and fourth chapters, Shamos searches for a definition of this term and finds many, which are not entirely consistent with each other. Some authors have meant understanding the process of the human quest to learn about nature. Others have seen science as a way of thinking which should be learned and applied in many areas of life. Still others have had purely practical goals related to workforce needs. The current goal seems to be to make citizens "sufficiently sophisticated in science to reach *independent* judgments on those issues that are brought to public notice by special interest groups or though the mass media." Of course, Shamos accepts the desirability of this goal, but he concludes that it will never be attained by more than a small fraction (3 to 6%) of the public. He also notes that social issues are more often based in technology than science.

Shamos follows this line of reasoning: scientific illiteracy is widespread, great efforts have been made to eliminate it, therefore it is impossible to eradicate. He offers only a bit of evidence to support his first point, but it is probably already widely accepted. He documents the second point in great detail, citing curricular revision and teacher improvements programs at all levels. To some degree, he undercuts his argument that we have made a maximum effort to reach scientific literacy by expressing cynicism about efforts in teaching science to non-majors: "How else to account for such promotional titles as Physics for Poets?"; "Their purpose, of course, is to attract the mathematics-shy student"; "The well-known custom of science departments to draw in students through attractive course titles, or by announcing no mathematics requirement, or by gaining the reputation for 'easy courses'." He also calculates the rate of scientific literacy necessary to make it very likely that a group such as a jury would include at least one literate, if not excluded by challenge. He finds the increase needed is far beyond what seems feasible.

The solution he proposes depends on a new definition of scientific literacy, which Shamos feels is both adequate and feasible. He wants a public that: knows what science is about; has an awareness of how it works; understands what can be expected from it; and knows how the public can best express itself in social/scientific matters. This last is taken to mean understanding how to use expert advice.

Shamos' program to achieve this is: "(a) introduce all topics through some relevant problems or issues in technology... meaningful to students; (b) work back to the underlying science where, and only to the extent, it is needed to account for the technology; (c) use the underlying science... to discuss... the role of experiment and the meaning of scientific truth, facts, laws, theories, etc.; (d) return to technology... for discussing the science/society interface; (e) conclude with when and how to use expert advice." This would certainly meet the objection that many students have to science courses — there is no opportunity for them to express their opinions. Shamos notes risks in implementing such a program: "technology education has been tried several times but without much success"; and there is little experience in teaching the use of experts. He also points out that a science curriculum does not stand alone, so "the new curriculum approach proposed here, barring other needed changes in our educational system such as better teaching, improved facilities, and greater support for education generally, may be equally ineffectual." Shamos remarks, many times, on cultural resistance to science, and seems to assume that it is immutable. He may well be right, but a major change in attitudes toward smoking occurred despite a lot of spending to preserve that status quo, so perhaps this attitude might also change. Shamos is attempting to reform science education, not mathematics education, but achieving his goals would seem also to require a good general statistics course because so much scientific information comes to the public through the lens of statistical summary or inference.

The third chapter, "The Nature of Science", includes a good introduction to the philosophy of science. It is not, however, well integrated with the rest of the book. This chapter, plus a tendency to repeat, lengthens the book beyond what is necessary for its central thesis.

A much more optimistic view is presented in an article by physics Nobel Laureate Leon M. Lederman. "Getting High School Science in Order", Technology Review, April, 1996, describes the fight for scientific literacy (in the traditional sense) as a winnable war. Endorsing the program of ARISE (American Renaissance in Science Education), Lederman sees reversing the usual high school science sequence — biology, chemistry, physics — as the key to success. This makes sense because chemistry is basic to biology and physics is basic to chemistry. The proposed courses would be somewhat less separated along disciplinary lines, even beyond use of prerequisite material from other sciences. Some topics would be revisited at more sophisticated levels as the students progressed. Of course, if large numbers of high school students were to take a three year sequence, it would, in itself, present the opportunity for great progress.

Lederman sees difficulties in providing new laboratories and teaching material, and in teacher preparation. If the mathematics program is not also revised, it would appear to create a serious difficulty that he has not mentioned. Although physics need not be taught in a highly mathematical manner, tenth-graders today have had very little geometry and no trigonometry. Can they do much physics without such background?

Two distinguished physicists, both of whom have thought deeply about science education for the public, have come to fundamentally opposed conclusions. On the one hand, that adjustment of the current curriculum can achieve scientific literacy, in the present sense of the term. On the other, that "scientific literacy" must be redefined, and that the new version can be achieved only by replacement of the current curriculum. This disagreement is further evidence of the complexity of the problem. Both of these approaches should be tested. Given the long time periods needed to evaluate an educational experiment, to implement a new curriculum on a large scale, and to realize the benefits in the adult population from educational improvement, the "scientifically literate" public is not just around the corner.

Robert L. Raymond
University of St. Thomas
St. Paul, MN 55105-1096

ERRATUM

Dick Bierman's research article "Exploring Correlations Between Local Emotional and Global Emotional Events and the Behavior or a Random Number Generator", which appeared in Vol. 10, no. 3, contained an error in the reference entitled "PRL Annual Report." The laboratory title should read "Princeton Research Labs," not "Psychophysical Research Laboratories." In addition, the reference is cited as PRL(1984) in the text and PRL(1983) in the references. The reference citation should read PRL(1984).