The Curricular Arena

Trial and Error. The American Controversy over Creation and Evolution. EDWARD J. LARSON. Oxford University Press, New York, 1985. viii, 222 pp. $17.95.

The rise of modern science and the spread of mass public schooling, though simultaneous, have not always been mutually reinforcing. In the United States, the rules that guide the selection of what is to be transmitted to children through public education are essentially political: their legitimacy comes from state constitutions, statutes, and legal precedent that tie public education explicitly to the authority of the government, which is based upon majority rule and consent of the governed. In contrast, the rules that shape the quest of science are methodological; their legitimacy springs from a set of conventions that experience has demonstrated to be successful for systematically observing, generating hypotheses, devising experiments, and perfecting theories about reality. Though it is true that scientific inquiry can be influenced by political considerations, the scientist is still free to inquire in ways the schoolteacher is not free to teach.

Because of this difference, the United States is a nation in which science education has the possibility of becoming a contradiction in terms. At times, basic modes of inquiry considered essential in science and social science, such as evolutionary thought in biology or theories of human development in psychology, have been inadmissible to the political culture of schooling. At other times, groups have sought legislation to enforce the teaching of preferred values and beliefs under the guise of science. This was the case with "scientific temperance instruction" at the beginning of the century and "creation-science" in recent years.

Beyond these obvious cases lies a larger disjunction between science and education. Schools teach codified knowledge under the wary eye of the public. In the political life of schooling, the continual strife over what should be instilled in children as knowledge tends to obstruct the play of open inquiry, favoring instead a consensus based upon accepted social values. Schools are purveyors not of science but of "public science," observes Edward J. Larson in *Trial and Error: The American Controversy over Creation and Evolution*. Public science, or "publicly supported science teaching and related activities," represents a compromise between scientific thought and popular opinion.

Such a compromise often comes about through legislation and litigation. In "public science," legal restrictions are the ultimate arbiters of disputes over school curricula. This angle of vision is the key to Larson's interpretation of science education in American high schools. The central concern of the book, evolution versus creationism in school curricula, is by no means a new story; numerous books and articles on the subject have appeared over the past decade, and there are no surprises in the evidence marshaled for this study. Nonetheless, *Trial and Error* complements recent studies by showing how legal rules and procedures, along with shifts in popular opinion, helped frame argumentative strategies and shape public decisions over the years. No other study succeeds so well at portraying the development of political argument and legal reasoning in historical context.

Of particular interest are the carefully drawn connections among celebrated cases, social movements, scientific culture, public perceptions, and the growth of schooling. The author brings to the task a fitting blend of training and perspective, possessing both a law degree and a doctorate in the history of science and having served as counsel for the Committee on Education and Labor in the U.S. House of Representatives. The main contribution of the book is that it traces clearly the legal controversies surrounding evolution and creationism in American high schools, but readers will also enjoy a vivid retelling of personal credos, political machinations, pedagogical developments, and other historical circumstances surrounding the vicissitudes of "public science" in the schools.

Most of the controversy has centered on the language of textbooks. Larson points out that one reason for concern was the tremendous expansion of the American high school, whose enrollments approximately doubled every decade between 1890 and 1940. An analysis of multi-edition textbooks between 1859 and 1920 shows the widespread adoption of evolution in the science curriculum during the early years of high school expansion. After 1920, these parallel developments met head on with the growing insecurities of disaffected groups hoping to preserve traditions of evangelical Christianity and strict morals against what they saw as the onslaught of secular and scientific modernity.

Describing the tension of "public science" and popular opinion against this background, Larson brings to life the strategies of the anti-evolution movement of the 1920's as it pressed for legislation in more than 20 states, succeeding in five. In an argument that may claim too much for the anti-evolutionists, he contends that the campaign against science in the schools was a product not only of fundamentalism—defined as a "religious movement for biblical literalism"—but of wider currents of progressive reform that were sweeping the country. The historical account draws from newspapers, speeches, tracts, books, the papers of William Jennings Bryan, and an extensive array of secondary literature. Adding to these sources the papers of Clarence Darrow and a complete trial transcript, the narrative goes on to summarize the ideological posturing and national attention that converged in 1925 on the *Scopes* trial in Tennessee, in which that state's law banning the teaching of evolution in the schools was upheld.

Evolution sank out of sight in high school textbooks for several decades after the 1920's. After years of neglect, the issue suddenly surfaced again by way of new science curricula developed with federal funds after the launching of Sputnik I by the Soviet Union in 1957. Perhaps the most useful contribution of *Trial and Error* is its depiction of the sequence of actions that first won legitimacy for evolution in school curricula during the 1960's and then maintained its primacy against creationist challenges through the mid-1980's. Using court records, organizational publications, newspapers, books and articles, statutes, legislative journals, and personal interviews, Larson provides a lively account of recent developments.

The ruling of the U.S. Supreme Court in *Epperson* v. *Arkansas* (1967) struck down that state's anti-evolution law. Since that time, judges have read creationist challenges to evolutionary teaching as unconstitutional attempts to establish religion in state institutions. Creationists have responded by devising new legal strategies as well as a research and organizational base for promotional

activities. The scientific establishment, educators, and legal action groups, in turn, have become better organized for explaining the difference between science and non-science in school curricula.

More subtly, according to Larson, judges have responded to popular opinion in finding anti-evolution and creation-science statutes repugnant to "the modern mind." Judges have shown deference toward greater public acceptance of the methods and social meanings of science in the United States. In so doing, it might be added, they have acknowledged a vital connection between scientific inquiry and the civic and social purposes of education in a democratic society. They have protected that connection against groups demanding a similar legitimacy for their own preferred systems of belief. In the political calculus that underlies "public science," the principle of majority rule has shifted the balance of power in controlling school curricula since the 1920's. Several strands of historical change help to explain this shift, notably demographic movements, political realignments, and higher levels of scientific education in the populace. Creationists, for their part, have shown an awareness of the shift as they have attempted to present traditional doctrines in scientific garb and, as a minority, to claim that without "equal time" their rights are being infringed upon, an argument that so far the courts have rejected.

What the author finds most interesting, and describes well, is the resourcefulness of the proponents on both sides as they have countered each other's strategies repeatedly in legislative chambers and courts of law. Since the contention is not likely to cease, this book merits attention for its many insights into the dilemmas of science education in a democratic society.

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The Character of Science

Changing Order. Replication and Induction in Scientific Practice. H. M. COLLINS. Sage, Beverly Hills, Calif., 1985. viii, 187 pp. $25; paper, $12.50.

The most difficult task of the scientist is to suspend judgment about what is true and what is not. This is precisely the task Harry Collins asks us to attempt in reading his important little book. The request is not made lightly. Public trust in science can only be maintained, Collins argues, if the public knows that facts do not speak for themselves, that disagreement among scientific experts is inevitable, that science is a human activity. In order to see the human character of science, we need to view the institution as though we were outsiders. *Changing Order* attempts to give us the necessary perspective.

Unfortunately, one must start this adventure with a heavy dose of philosophy. Fortunately, Collins's sense of humor makes the dose tolerable. He has us contemplate Wittgenstein's views of rules by playing a game called "Awkward Student." A joke about an Indian elephant illustrates the central questions of artificial intelligence. We approach the problem of replication as mice who have commissioned the Earth as a computer. The message is heavy, but the reading is just light enough to get most of us through to chapter 3. Once there, we are likely to stay the course.

Chapters 3, 4, and 5 report case studies that forcefully illustrate Collins's central points. They are rich in the details of scientific practice and make good reading. The dramatic saga of a TEA laser (transversely excited atmospheric-pressure CO_2 laser) calls into question the common picture of nature as "orderly and cooperatively passive," yielding truth in response to experiment. Instead, the case shows, the production of facts is the only available indicator of when an experiment has worked. Collins draws the conclusion that knowledge is not produced algorithmically.

The lack of independent criteria for "successful" experimentation results in what Collins calls "experimenter's regress." The criterion for successful procedure is fact, and the criterion for fact is successful procedure. "Experimental work can only be used as a test [of the validity of a knowledge claim] if some way is found to break into the circle," Collins writes, and illustrates the point with the controversy over gravitational radiation. The specific criterion that breaks into the circle will vary from case to case, but the development of consensus around the successful criterion is always a social process, not a mere exercise in logic. The third case, experiments in the paranormal, again shows "why and how the test of replication fails to work efficiently in disputed areas" (the only areas, Collins claims, where replication is ever used as a test).

The cases establish the plausibility of Collins's general claims, which are presented in chapter 5. A postscript spells out their implications for the politics of science. The algorithmic model of science encourages the view that method alone produces scientific knowledge. A mantle of infallibility becomes the basis for public trust and support for science. This view, Collins argues, is dangerous, since every instance of public disagreement over "the scientific facts" erodes the aura of infallibility. As an alternative, Collins proposes the enculturational model, the model the book explicates and illustrates. In this view, the locus of knowledge is not method but the community of expert practitioners. Scientists are seen as the best available consultants on a variety of matters rather than as infallible authorities.

The first model allows the citizen only two responses to science: awe or rejection. The second allows for a different kind of respect and forces the public to recognize the lack of purely technical solutions to political, moral, and technological decisions. The latter view is thus safer, according to Collins. To ask too much of science is to risk a widespread disillusionment our times can ill afford.

The argument is worth considering. *Changing Order* presents the case for the enculturational model as effectively as other, longer and less concrete, volumes that share its viewpoint. For both reasons, the book is worth the effort of thought experiment it requires.

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Surface Science

Many-Body Phenomena at Surfaces. DAVID LANGRETH and HARRY SUHL, Eds. Academic Press, Orlando, Fla., 1984. xiv, 578 pp., illus. $39.50. From a workshop, Santa Barbara, Calif., July 1983.

The quest to understand the many-body problem has long been a driving force in physics. This problem refers not to the racy possibilities one might imagine but to phenomena associated with the behavior of many interacting particles; for example, the book under review is concerned with the behavior of electrons and ions in solids. Although we have precise knowledge of the elementary Coulomb force between any pair of particles, the behavior of many particles is complex, often exhibiting novel behavior in the limit of large numbers. This is particularly so for the ultra-slippery