thinking? The informed consent rule is not a way to protect patients from unnecessary procedures. If followed liberally it will produce more health havoc than legal protection.

Conclusion

Those familiar with malpractice problems realize there is no panacea in sight, nor is one expected in the immediate future, at least of the type which would satisfy most parties. There are just too many variables in the present situation. Therefore, physicians must seek practical methods to reduce malpractice threats. This is no less true for clinical laboratories. Recognition of potential pitfalls, particularly those which have plagued less fortunate colleagues, is a start in that direction (7). To assist in this I have subdivided usual laboratory conduct into four phases: obtaining the specimen, performance of tests, reporting and supplying, and consent. For each phase I have briefly presented the more serious and common issues which have developed in malpractice cases. Awareness of these may prevent some from occurring. If an injury does occur, however, proof that it happened despite diligent preventive measures and adequate management certainly increases the probability of a successful defense.

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Curriculum Reform

Courses and teaching methods are changing at all levels, not just in high school, where it all began.

John Walsh

This year for the first time, textbooks and supplementary materials in the "new" biology and chemistry for high schools are generally available and are selling well. Courses in the new physics and mathematics preceded biology and chemistry, and it appears that the curriculum reform movement has reached its first major way station.

What has been heralded as a revolution in the teaching of science and mathematics in secondary schools is also having an agitating effect on elementary school and college curricula, on teacher education, and on commercial textbook publishing. And like other reform movements, curriculum reform has produced some interesting secondary aspects. It can be argued, for instance, that the effort to improve course content has had a vitalizing effect on educational research and, judged on a cost-effectiveness basis, is the most important program of federal aid to schools extant.

The operative principle in the current curriculum reform effort is the collaboration of research scholars and school teachers, financed by the National Science Foundation.

Like a good many NSF programs, the course content improvement projects, as NSF calls them, are not mentioned in the statute establishing NSF, but were created out of a general feeling of necessity and are based on the agency's responsibility for strengthening science education.

While most proposals for federal aid to schools become tangled in congressional barbed wire, the course content projects have remained remarkably uncontroversial. In part this may be because the program required no separate legislation and was handled administratively. But the explanation for the peaceful progress lies probably in its lack of ingredients to ignite religious or racial issues, which make legislative powder kegs of most school aid proposals. NSF has also leaned over backward to avoid any suggestion of federal control.

Furthermore, the cost of the program has been relatively modest, although the annual bill is rising steadily. Something over $50 million has been spent since 1954. The annual budget has reached about $14 million, but this represents a small part of the $350-million NSF budget and is an inconspicuous amount compared with billions spent on public education by state and local governments.

A pattern for the present round of curriculum reform seems to have been set before NSF took the plunge with support of a major project in 1956. Many people date the beginning of the present surge back to the establishment of the University of Illinois Committee on School Mathematics (UICSM) in 1951. With Max Beberman as chairman and the Carnegie Corporation as patron, UICSM proved a prototype both in aims and organization.

In the early 1950's the chorus of lament from university scientists about the widening gap between science as practiced by the researcher and science as taught in the high schools had kindled NSF concern over high school teaching. But a catalyst was needed to get the agency committeed, and the function seems to have been performed by Jerrold R. Zacharias, physics professor at M.I.T.

Zacharias had made some public statements about the responsibility of university researchers for helping in the modernization of high school science and math curricula, and after a series of conversations which culminated in a meeting between Zacharias and NSF director Alan Waterman, there emerged the idea for the Physical Sciences Study Committee (PSSC), which was to produce the pioneering course in the new physics.

Zacharias, a persuasive man and a driver, remains an active and influential figure in the curriculum reform

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movement. NSF officials familiar with the history of the movement say that Zacharias deserves credit for establishing a key precedent by persuading first-rate university researchers to take part, not simply as consultants but as participants in the basic work of the study groups.

The PSSC effort got under way in 1956, and the first materials were ready for wide distribution in 1960. The PSSC course was developed through writing sessions in which preliminary materials were prepared and then used in pilot testing programs in schools. The materials were then revised in the light of "feedback" in later writing sessions. This became the established method for other groups. PSSC supplemented its basic textbook, lab manual, and teacher's guide with films and a series of paperbacks on specific subjects, and other groups followed a similar pattern.

In the late 1950's, the New Deal in science and math for the high schools broadened as new groups, known by new acronyms, were created; The School Mathematics Study Group (SMSG), the Biological Sciences Curriculum Study (BSCS), the Chemical Bond Approach (CBA) project, and the Chemical Education Material Study (CHEMS) were the main ones.

Swing of The Pendulum

This remarkable burst of activity, which united university researchers and high school teachers in efforts to rebuild the curriculum, in a sense represents a sharp swing of the pendulum in American education. Roughly half a century ago, American high schools were primarily preparatory schools for college. High school textbooks were generally written by college professors, and high school teachers usually held regular degrees in the arts or sciences from colleges or universities. As mass education extended upward into the high schools, the pattern changed. Commercial and other utilitarian courses for students not headed for college were added to the curriculum, and new institutions evolved from the normal schools began training the large numbers of teachers needed for the high schools.

In the 1920's and 1930's the rise of progressive education, with its emphasis on theories of child development, had considerable effect on organization, curriculum, and teaching methods in the public schools. In the high schools, the triumph of the elective system resulted, generally, in a relaxing of requirements in college preparatory courses. As a rule, textbooks were written by teams of teachers, curriculum specialists, and consultants deemed competent to advise on suitable vocabulary and level of difficulty of the content. College and university faculty members engaged in research were largely divorced from these endeavors.

The estrangement between teachers of science and mathematics in the high schools and those in the colleges gained greater significance, perhaps because it began to be evident in the early years of the century, when Einstein and Bohr were doing their crucial work.

After World War II, public consciousness of the national security implications of science, together with the pressures of technological change and unemployment, focused attention on the quality of science and mathematics training in the high schools. It is worth noting that the PSSC project was undertaken before the Sputnik I launching had its galvanizing effect on the American public and American education. It is probably true, however, that PSSC seemed a more urgent matter to the academic community, and a more interesting proposition to some public educators, in the wake of Sputnik.

Curriculum reform has presented problems in diplomacy as well as in course revision. Working relations had to be reestablished between the professors on the one hand and the teachers, supervisors, and administrators on the other, and this was often a delicate task, since the schoolmen were smarting from criticism of their schools and some of the sharpest barbs had been hurled by critics in the colleges and universities.

Enlisting high school teachers to serve on equal terms in the projects helped, but the study groups had to avoid the appearance of promulgating new curricula from Olympus.

The Physical Science Study Committee was not organized to undertake a specific project. As the name implies, chemists as well as physicists were involved in the original group, but after joint meetings produced no decision, the physicists decided to go ahead and the idea of concentrating on a high school physics course fairly quickly evolved.

Physics

It is significant that the PSSC course was designed from the start to fit into the standard high school curriculum and schedule. Physics, for most, is an elective subject in the 11th or 12th grade. Most students who take it are preparing for college and are ordinarily drawn from the upper half of the class academically. For the professors there was the advantage that the students were more like college students than elementary or junior high students would be, and that there was an existing corps of physics teachers, though many of them were not well prepared. Iconoclasm was ruled out from the start.

Gilbert C. Finlay, professor of education at the University of Illinois, who has been involved in the committee's work over a period of years, has set forth the aims of the PSSC in the following terms.

"The committee chose to plan a course dealing with physics as an explanatory system, a system that extends from the domain inside the atom to the distant galaxies. The course tells a unified story—one in which the successive topics are chosen and developed to lead toward an atomic picture of matter, its motions and interrelations. The aim was to present a view of physics that would bring a student close to the nature of modern physics and to the nature of physical inquiry. Finally, the committee sought to transmit the human character of the story of physics, not simply an up-to-date codification of the findings. The student should see physics as an unfinished and continuing activity. He should experience something of the satisfaction and challenge felt by the scientist when he reaches vantage points from which he can contemplate both charted and uncharted vistas.

"Achieving these aims in a 1-year course meant that coverage of the field of physics had to be sharply restricted in favor of a deeper development of ideas that are central to a comprehension of the fundamentals of contemporary physical thought. This deeper development meant carrying key concepts to higher levels than have been ordinarily reached in secondary-school courses. Deeper development also meant a more extensive exploration of the substructure of experiment and thought that underlies the basic physical principles" (*The School Review*, Spring 1962, p. 65).

The new PSSC course, which was the first of the new courses to achieve general use, also had to pioneer in solving the problems. For example, ordinary achievement tests in physics were ill designed to test achievement in the PSSC course, and it also became apparent that College Entrance Examination Board (CEEB) tests were not appropriate, a fact of great importance to seniors aspiring to admission to prestige colleges. CEEB averted a crisis by agreeing to provide a special test suited to the content of the PSSC course.

The new courses' emphasis on laboratory experimentation has also caused them to be viewed by some, with reservations. In the case of physics, again, it is suggested that technology has been downgraded and that this may have contributed to a decline in engineering enrollments.

Biology

The biology study group also concentrated on high school courses at the start. Bentley Glass, of Johns Hopkins, became chairman of the BSCS under the American Institute of Biological Sciences at the time AIBS backed formation of the study group in 1959, and he has served as chairman of the BSCS continuously. Glass describes the BSCS choice this way.

"At the outset it was decided to begin by tackling the problem of biology at the high school level. Although the defects of biology teaching in the elementary school or in the colleges may be fully as great, it is in the secondary schools that most choices of occupation are made; it is here that one finds the last opportunity to teach the sciences, and specifically biology, to nearly every future citizen; and clearly much of the difficulty in interesting students in the study of biology at more advanced levels derives from the failure of high school biology teaching to awaken interest commensurate with its importance, or even arises from the quenching of interest in any curiosity about the nature of living things which is so characteristic at an early age."

The tactical situation facing BSCS was a different one from that which had confronted PSSC. Biology in most American high schools is a 10th-grade subject. It is the most popular high school science in the sense that it is taken by more students than any other and the students show a greater range of ability. Biology in a great many places has been taught as a classroom subject with a few demonstrations. Authentic laboratory work has been required in relatively few schools.

The BSCS group set out to develop not one but three courses. These variations on basic themes came to be called the Green, Blue, and Yellow versions, with the Green stressing an ecological and evolutionary approach, the Blue a biochemical and physiological approach, and the Yellow a genetic and developmental one.

In order to stress what Glass calls the "investigatory function" of laboratory work rather than the "illustrative function," the BSCS group devised the (optional) "laboratory block." For a period of several weeks, biology classwork and assignments and regular laboratories are suspended and students concentrate in groups on specific problems. These studies in depth, which give students opportunities to pool and analyze data, were developed and pretested in the same way that the text and regular laboratory courses were.

The BSCS group had to decide at the start what to do about certain aspects of biology which might be controversial—evolution, racial differences, sexual reproduction, radiation effects. Many commercial textbooks avoided the problems by giving these inflammable subjects short shrift, some ignored them entirely. The BSCS committee decided, says Glass, "not to pull any punches" and to treat these subjects with full clarity in the appropriate places, but at the same time to avoid "ethical, moral and legal judgments." So far, it seems, the policy has prompted no serious adverse reactions.

To provide teachers with a rationale for the new BSCS course as well as to furnish fuel for class discussion, a teachers' handbook was developed. It is meant for teachers of classes of any of the three BSCS versions, and it stresses the major themes which underlie the three courses.

Teacher Training

A decisive element in the curriculum reform campaign, of course, is the ability and willingness of teachers to move from the conventional to the new curricula. NSF from the beginning has drawn the line clearly on its own activities in the curriculum field. The agency would finance development and testing of the new materials but would not interfere with decisions at the state and local level on the use of course material. NSF would provide information when asked, but would not pay for textbooks, for example, or underwrite the cost of instituting the new courses.

In practical terms, the upgrading and retraining of teachers required by the new math and science courses has been accomplished primarily in the summer and in academic-year and "in service" institutes in math and science sponsored by the foundation.

Because, for instance, many teachers attended more than one institute session and because many who attended institutes subsequently stopped teaching, it is very difficult to determine how many active teachers have had institute training. By rough estimate, however, it appears that perhaps 40 to 50 percent of the 200,000 high school math and science teachers have attended the institutes since 1959.

How well this has prepared them to teach the new courses is even more difficult to say. Not all of the institutes, by any means, have been based on the materials produced in the course content improvement program, and the quality of those that have been based on the program has varied widely.

Materials and Textbooks

Some school districts have conducted their own seminars and training courses in the new curricula, and others have adapted the new materials to their own uses. The sale of textbooks gives a concrete clue to how widely the new courses are being taught, but not, it seems, to how well. (In the 1963–64 school year, it is estimated, 1.8 million students took one of the SMSG series of courses for grades 4 to 12. It is thought that some 35 to 40 percent of high school physics students are enrolled in PSSC courses, with perhaps another 15 percent using some PSSC materials. An estimated 250,000 BSCS texts were sold this year, and both CBA and CHEM study texts are reported to be selling better than had been predicted.)

In practice, local decisions on curriculum changes are heavily influenced by what textbooks are available, and in the field of textbook publishing the curriculum study movement has produced a real ferment.

Since the government subsidized development of the new courses, a potentially troublesome set of questions were involved in arrangements for publishing texts and materials. To protect itself from charges of favoritism, NSF worked out with PSSC the pattern which was to serve in general outline for the biology and chemistry groups. Each study group was to ask for competitive bids on texts and materials and to choose what they regarded as the best proposal, subject to confirmation by NSF attorneys. The recipient of the NSF grant was to hold the copyright, and royalties were to be put in escrow for the grantee, to be used for purposes approved by NSF—in some case for further work on curriculum study. The commercial publisher also had to agree to some unusual contract clauses, such as that books and materials would be competitively priced and the authors would have the right to withdraw or revise the text and materials. It was also understood that the publisher was not to represent the course material as "government approved," but this stricture is a somewhat formal one, since most potential customers are aware of the pedigree of the study group courses.

Commercial publishers seem to be learning to live with the new system, if uneasily. Their nightmare of government-sponsored textbooks rolling off the presses of the Government Printing Office has not materialized, but the publishers still are not pleased at having their role reduced to one, essentially, of printer and distributor as the function of editor has been taken out of their hands.

A statement of policy by the American Institute of Textbook Publishers, the chief association of the trade, makes it clear that the publishers would like to be more closely involved in the development of the curricula and that they want assurances that all federally subsidized new material will be opened to competitive bidding and, perhaps most particularly, assurance that tax-exempt organizations will not be permitted to compete with private enterprise.

The School Mathematics Study Group has followed a publication pattern different from that of the science study groups. The SMSG and UICSM courses are published in paperback form by university presses and are regarded as "sample texts," which are available for adaptation by all commercial publishers. Some publishers like this free-for-all policy, some do not.

In a few cases, members of study groups have severed connections with their groups and have contracted to write texts on the study-group subjects. This is viewed as fair practice so long as the products differ sufficiently from the study-group work to obviate any difficulties with royalties. For the most part, however, the study participants seem to have gone back to the classrooms and laboratories or on to other projects.

Future Revision

As the curriculum study projects multiplied and as some of them neared their objectives, the question of revision and continued work in related projects came up. PSSC established a nonprofit corporation, Educational Services, Incorporated, in Watertown, Massachusetts. BSCS has maintained from the beginning a base of operations and a staff at the University of Colorado, in Boulder, to insure administrative continuity and control.

NSF apparently has some reservations about the continued existence of specific study groups, becoming rather like holding companies, but the creation of ad hoc groups to accomplish a specific job and then to be dissolved —as was apparently the original conception—seems not to meet emerging circumstances.

Lack of coordination among the original study groups working on the high school courses has already resulted in a demand for revisions which will allow the courses to be taught in a more coherent and integrated way. It is expected, also, that better science and math instruction in the lower grades will soon exert pressure for further changes in the high school courses.

Curriculum reform on the present pattern appears to be long-term unfinished business from which NSF would have difficulty extricating itself even if it wanted to.

Curriculum changes in one field and at one level have, demonstrably, led to changes at other levels and in other subjects.

There seems to be general agreement that students entering colleges and universities these days are better prepared in science and math than was formerly the case, and that, as a result, undergraduate science and mathematics courses have to be overhauled and upgraded. The improvement in the freshmen cannot be ascribed exclusively to the modernized curriculum. High school students headed for college take more science and math than they used to and, as a result of stiffer competition for admission to the better institutions, the weaker students of yesteryear do not get in. But the contribution of course reform clearly has counted. And by way of tribute through imitation, NSF-supported study groups this year are working on the development of college courses that match the new secondary curricula, and reflect the most recent advances in biology, chemistry, engineering, mathematics, physics, and social sciences.

Much more extensive efforts are being made on curriculum reform in the junior high school and elementary school. The same alliance of teachers and university faculty members in particular disciplines is being employed, but it is acknowledged that it is difficult for a university researcher to apply his knowledge of a subject in the teaching of children below the high school level, since it is necessary to know not only a lot about mathematics, for example, but a good deal about children.

Effects

The reformers have had to deal in detail with problems of what to teach, when to teach it, and how to teach it. And the experience has stimulated in many of them an interest in the learning process itself, and in the special problems of teaching slow learners and the culturally deprived. Until recently, educational research has been regarded as a backwater, but recent work in the field of cognitive psychology and the curriculum groups' confrontation with the underlying problems of pedagogy seem to be restoring both respectability and élan to those engaged in this sort of research.

At the high school level, where it all began, the consequences of the reform movement are still far from clear. For example, in its newsletter of 20 March the American Institute of Physics, which has kept close track of the progress of PSSC, quoted an Office of Education Study showing that enrollment in high school physics courses increased very little between 1958 and 1962. Despite a rise in total high school enrollment from 10.7 million in 1958 to 13.5 million in 1962, the number of enrollments in physics rose only from 379,000 to 397,000. In percentage terms, physics enrollment has dropped from 26.4 percent of the total to 22.2 percent. In the same period, enrollment in chemistry rose from 657,000 to 859,000, increasing from 37.6 percent to 38.2 percent of the total.

The reasons for this are not clear, and, as the newsletter says, "the static enrollment in high-school physics is cause for serious concern for physicists and others interested in strengthening science in the United States. Many questions arise. Has physics content merely been displaced from the one-year course to other courses—such as 'physical science' or 'general science'—and in fact is still part of the education of most children? Is the one-year course in physics to be replaced by bits and pieces of physics distributed through the other science courses? Is the level of expected performance in present physics courses too high for the 'average' student? Are college-bound students avoiding physics courses because they think a poor physics grade will reduce their chances for college admission? Are the shortage of competent physics teachers and the uncertainty about course content such that schools are gradually ceasing to make the effort to offer a physics course?"

These questions direct attention to the central problem, that of the assimilation of the new curricula by the behemoth of American public education, with its decentralization, its conservatism, and its formidable difficulties with such practical matters as finance, school size, staffing, and scheduling.

It is also to be noted that the reformers have so far made indifferent progress in carrying the message of the modernized curriculum to the teacher-education institutions.

These qualifications notwithstanding, the results so far show that the triple entente of teachers, researchers, and federal patron have made a most extraordinary contribution to the substance of what is taught in the schools. And major credit must go ultimately to a relatively few scholars who stopped cursing the dark and started lighting candles.

The Information Explosion—Real or Imaginary?

An emerging design for a national system of handling scientific and technical information is described.

John C. Green

In recent months I have heard a number of people speak on such topics as "the information explosion in our times," "the impact of science on our society," and "Is the federal support of scientific research impairing industrial progress?" The speaker usually starts by quoting statistics concerning the federal government's involvement in research and development, which is currently on the order of $15 billion a year. Then he points out that this is 15 percent of the total federal budget, or, expressed another way, over two-thirds of the total national expenditure on research and development by industry, universities, and foundations. The speaker usually proceeds to point out the impact on his pet scheme of these involvements of dollars and personnel. If the economy is lagging it is because we have too many scientists endeavoring to put a man on the moon. If it is difficult to find anything commercially useful in all these research studies it is because we don't have computer storage and retrieval of scientific and technical information. And so it goes.

It seems worthwhile to question some of these premises and conclusions. For example, does the fact that government is allocating billions each year to industry to pursue technical activities in support of government missions have a substantial impact on our economy one way or the other? The federally sponsored efforts are usually separated from the regular work of industry, and the latter doesn't fall off when a company increases its involvement in government contracts for research and development. Moreover, industry continues to carry on research and development of its own to the degree that this proves valuable to it from the standpoint of planning, objectives, and resources. Industry's own expenditures for research and development have more than doubled in the last decade.

My point here is that prudent decisions on the part of management, not federal efforts, control the amount of funds private industry allocates to sales, engineering, diversification, and research and development. To the degree that research and development will increase dividends to stockholders and will promote company growth, it will be supported by management.

The Government Report

Let us look next at the explosion of scientific information, which we are told is caused largely by these massive federal expenditures. It is true that the multiplicity of federal contracts and grants calls for reporting of progress at regular intervals. This is required for three reasons: (i) to keep the contracting agency in touch with work it is supporting; (ii) to make sure that significant findings are recorded and disseminated; and (iii) to identify anything of a patentable nature, so that steps can be taken to protect the con-

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