Science Education for Nonscience Students

A new interdisciplinary effort at Berkeley aims to acquaint college students with modern science.

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The need to impart to all students some familiarity with modern science has come to assume an importance far transcending the traditional virtues of a liberal education. Even if their future occupations should be far removed from scientific fields, all of today's college students will have to live in a world increasingly dominated by the rapid expansion of science and the proliferation of its technological consequences. Furthermore, whether as ordinary citizens or in the positions of leadership which they will attain as a result of their higher education, they will often be called upon to make decisions involving scientific considerations. Many of these decisions will significantly affect the quality of life in our society; others will also determine the degree of future support allocated to the furtherance of science. Thus it is essential that, although relatively few students are likely to acquire scientific expertise, all of them should have sufficient awareness of modern science to be free from misconceptions and better prepared to make value choices too important to be left entirely in the hands of "experts."

Even though the desirability of providing some kind of science education for nonscience students has been recognized in many colleges, the actual implementation of such education has, with few exceptions, attracted little serious attention from the faculty (*1*). As a result, science courses intended for nonscience majors have all too often been neither inspiring nor illuminating, a chore to the instructor and a burden to students who are forced to fulfill some science requirement. In an attempt to remedy this situation, a new course program has recently been instituted at the University of California in Berkeley.

My purpose here is to describe this educational experiment in the hope that others might profit from our experience and find in it suggestions of possible value to them. I do not wish to claim that our program at Berkeley is completely unique or novel. Nevertheless, it should be useful to point out some promising approaches and some difficulties encountered in trying to provide, within the context of a large research-oriented university, a meaningful science education for nonscience students. I should be gratified if our example would encourage more scientists to consider the scientific education of nonspecialists as an important problem which deserves attention and which constitutes a genuine intellectual challenge.

Goals and Approach

In undertaking the task of teaching science to nonspecialists, it is very important to specify clearly the goals to be attained. Our main premise has been that we should not primarily aim to teach the manipulative skills (involved in solving problems, applying mathematics, or handling laboratory equipment) which constitute the predominant content of the usual science courses designed to train students intending to become scientists or engineers. In addressing students who will never use science professionally, we wish instead to impart to them a coherent perspective about some fundamental ideas of contemporary science, about what modern scientists do, and about the ways in which science interacts with the rest of society. Thus we are not interested in presenting a mere survey of scientific facts and results. We want rather to discuss a few key ideas, presenting them in their simplest possible form without excessive detail, yet preserving their essence in a manner that is thought-provoking and stimulating. Furthermore, we wish to provide the students with a learning experience which should endow them in later life with both the interest and the ability to keep informed about scientific matters that might be discussed in the popular press.

We have sought to accomplish a substantial educational improvement while working within the prevailing limitations imposed by the nature of the student body and of the university. The nonscience students, many of them forced to take a science course because of an imposed college requirement, are initially likely to be indifferent and perhaps even hostile to science; their mathematical preparation is usually poor; and they are extremely heterogeneous in their educational background and current interests. The time available to teach science to these students does not appreciably exceed that of a 1-year course. Furthermore, even though the number of such students is very large, the research-oriented university contains among its faculty only very few scientists who have both the ability and motivation to devote some attention to teaching students who do not intend to become scientists.

In attempting to realize our aims within the limitations imposed by these realistic constraints, we proceeded to develop a new interdisciplinary course sequence, called the Contemporary Natural Science (or CNS) course, which is designed to deal with some of the fundamental ideas of physics, chemistry, and biology in a manner that minimizes the distinct boundaries between these fields. (The course, extending over 1 year, is accordingly taught as a collaborative undertaking by three faculty members with main professional competence in these respective fields.) The interdisciplinary approach should prevent giving students too narrow a vision of the scope of modern science, should increase learning efficiency by assuring that the background knowledge prerequisite for certain subjects (such as some topics in biology) has been provided in ear-

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lier stages of the course, and should have enhanced intellectual interest by the inclusion of recent developments which have made increasingly apparent the close connections between the biological, chemical, and physical sciences.

We believed that the success of the CNS course program would require that the following conditions be satisfied:

1) The subject matter must be selected very carefully and must be presented in a unified manner.

2) Active participation of the students is essential and personal involvement with them is required, despite the large size of the class (nearly 600 students per lecture). Hence there is a need for small discussion sections and, particularly, for good teaching assistants to be employed more effectively than is customarily the case.

3) A suitable means must be found so that these nonscience students can obtain some firsthand experience with natural phenomena without being subjected to the uncongenial context of conventional laboratory work.

4) The course should provide for effective cooperation between professors, teaching assistants, and students and should facilitate adequate feedback from students to the teaching faculty.

5) The course must acquire the reputation for being intellectually stimulating to the students, as well as to the professors and teaching assistants involved in it. Otherwise, it will neither appeal to the students nor attract good teaching faculty and will quickly deteriorate in quality.

Let me now discuss how we have attempted to satisfy these requirements in practice.

Structural and Background Themes

Although a course of the kind described might be given coherence by building it around the historical development of scientific ideas, we rejected this approach for the following reasons. (i) We wished to emphasize the contemporary context of the sciences since it is likely to be most relevant and interesting to the students. (ii) It is pedagogically simpler and logically more satisfying to exploit the powerful insights of modern scientific concepts instead of forcing students to recapitulate all the twists and turns of outmoded theories. (iii) It is not necessary to use history as the organizing principle of a course in order to achieve the aim of imparting to students some awareness of the historical development of ideas or the sociology of science.

Therefore, our basic approach has been to select a few themes, basic ideas of great significance, to serve as the structural skeleton of the course. These structural themes, illustrated and elaborated with pertinent facts and examples, are always kept in the forefront. They give coherence to the discussion and facilitate learning by the students. They also help to emphasize that science is more than a collection of observations and gadgets, and that it aims to organize knowledge and to formulate concepts of great generality. In addition, although students are likely to forget most of what they are taught, the few essential themes stressed in the course should linger with them in the years to come.

Discussing themes that reveal unifying relations and deeper insights is not only intellectually satisfying to both the instructors and the students; it also constitutes good strategy for dealing with students of heterogeneous background. The complete novices among them do not get lost since they can concentrate on a few essential ideas, whereas those with prior exposure to some high school science are not likely to get bored since they come to see woods where before they saw mostly trees.

For the sake of concreteness, let me mention a few specific structural themes that we have found useful. For example, one theme of wide relevance is the principle of superposition. This principle (first used in mechanics to find the total force due to several particles) can be made the foundation of the entire discussion of wave motion. The principle asserts that the amplitudes of two wave disturbances are simply added to obtain the resultant amplitude. This idea leads immediately to an understanding of the phenomena of interference, diffraction, and standing waves. The notion of a wave becomes, in turn, a fundamental theme which provides the common basis for a discussion of the properties of sound, light, and radio waves. Quantum ideas are also fundamentally concerned with the superposition of amplitudes (rather than probabilities) and with the seemingly strange interference phenomena resulting therefrom. Furthermore, these quantum ideas can be combined with the previously gained understanding of standing-wave patterns to give systematic insights into atomic structure.

The theme of order as opposed to randomness can be made the cornerstone for a discussion of all large-scale systems consisting of many particles. This theme leads immediately to an understanding of irreversibility, the realization that naturally occurring processes tend with overwhelming probability to approach situations of greatest randomness. Such situations are then time-independent, that is, they correspond to equilibrium. The diffusion of molecules throughout a box provides a vivid example of an irreversible process that results when molecules tend to become more randomly distributed in space. The important notions of heat and temperature arise quite naturally when one considers two systems free to exchange energy; as the total energy of the systems becomes randomly distributed over all their molecules, energy (that is, "heat") is transferred from the system of larger energy to the system of smaller energy until the average energy per molecule (that is, "temperature") becomes the same for both systems. The solid, liquid, and gaseous forms of a substance represent merely different forms of aggregation of the same molecules characterized by different degrees of order. A heat engine or a biological organism is cleverly contrived to produce higher order in one system at the expense of the introduction of a compensating amount of randomness into its environment.

A theme of transcending importance deals with the operationally significant use of language. By stressing this theme, we hope to develop in the students a critical awareness of the relation between observable phenomena and symbolic conceptual constructs, an awareness quite important even outside the domain of the physical sciences. Furthermore, this theme provides the framework for a discussion of the most basic concepts of 20th-century physics. The task is to question what observations one must perform in order to ascertain whether any particular symbolic statement is true or false, and to use this test question to discard any words or symbols which may, in fact, have no bearing on observable reality and which may thus be replaced by more appropriate concepts. For example, the theory of relativity may be approached from a consideration of the apparent paradox that the experimentally measured velocity of light is the same for observers moving relative to each other. This paradox raises the question of how one actually measures a velocity, shows that properly synchronized clocks are required at two locations, and demands examination of the actual procedure used for synchronizing clocks. The outcome is then a critical understanding of the notion of simultaneity, a realization that this concept is one relative to different observers, and an appreciation of the resulting consequences of the theory of relativity. As another example, the basic ideas of quantum theory can be approached by a consideration of the apparent paradox that photons passing through a double-slit arrangement are observed to act as particles and yet give rise to an interference pattern characteristic of waves. This paradox raises the question of whether one can, indeed, ascertain whether a photon goes through one slit or the other. Examination of this question shows that simultaneous determination of the position and velocity of a photon is not possible, reveals the inadequacy of classical notions of definite particle paths, leads to the Heisenberg uncertainty principle, and opens the door to the quantum-theoretical mode of description.

Additional themes could be mentioned, for instance, the theme of invariance (encompassing the theorems of the conservation of energy and momentum, charge conservation, and also symmetry) or the theme of evolution (biological as well as chemical). The examples already given should, however, suffice to make clear the notion of a structural theme. The important points are that only a few structural themes are emphasized throughout the course and that each one of them has many far-reaching implications. In addition, the degree of elaboration of each theme is judiciously limited so as to convey the essential ideas, provide a few simple examples, but avoid excessive detail. Selectivity and self-restraint are crucial virtues since it is all too easy to accomplish less by trying to say too much. For instance, in discussing the theory of relativity, the important aim is to impart an understanding of the notion of simultaneity and to show that the apparent violation of commonsense notions implies no real paradoxes. (This aim can be achieved without the inclusion of any mathematics.) On the other hand, it would be unwise to become involved with formulas for the relativistic addition of velocity or with similar details of the theory of relativity (*2*).

In addition to the structural themes which provide the organizing skeleton of the course, we have stressed several background themes, recurrent ideas calculated to make students aware of significant aspects of the nature of science or its relation to society. Such ideas become most meaningful when their relevance is pointed out in concrete contexts provided by the discussion of the scientific subject matter. Thus the course provides many opportunities to point out the nature of "scientific explanation" and to contrast it with uncritical verbal statements based on common sense or on philosophical preconceptions. (It is, indeed, remarkable to find that, although students have asked the question "why" ever since they learned to talk, most of them have never asked themselves what kind of answer they would accept as a satisfactory explanation.) Many instances can be used to illustrate explicitly that scientific concepts are not God-given but are the outgrowth of creative human imagination; that a theory may have a limited domain of applicability without being wrong; that there is an intimate reciprocal interplay between theory and experiment, as well as between pure and applied science; and that a new discovery or abstract concept in pure science may lead to ultimate consequences that were originally quite unpredictable and yet have a major impact on society.

There also arise in the course many concrete instances that exemplify the general paradigm that any knowledge acquired about the observable world leads to the power to predict and hence to control, and that all such power can be used or misused. Since stopping the production of new knowledge may lead to even greater harm than knowledge misused, there is no choice but to face squarely the question of how, and by whom, decisions are made about the proper use of this power. It is then worth pointing out that science does not prescribe value choices, that scientists are not qualified to make all decisions, and that the students themselves, as members of society, will have to take responsibility for some of the decision-making processes.

"Demonstration Laboratories"

The CNS course has two complementary aspects: presentation of subject matter and active student participation. Presentation of the subject is accomplished by lectures (three per week given to an audience of about 600 students) supplemented by some collateral reading assignments. These lectures give the faculty in charge of the course the opportunity to develop the important themes in as interesting and thought-provoking a manner as their talents permit. But reading and listening to lectures are fairly passive occupations. If students are to learn anything meaningful, they must become involved with the subject matter in a more intimate and direct way. Hence the class is subdivided into small sections, each consisting of about 15 students, which meet for 2 hours a week under the supervision of a teaching assistant. The proper selection and role of these assistants is an important issue which I shall discuss below. Any one teaching assistant is in charge of a maximum of three sections. Hence he deals with at most 50 students, a number small enough so that he can get to know them individually. He spends with each section 1 hour a week trying to promote discussion and questions by the students; the other hour he spends with his section in what, for want of a better name, we have called a "demonstration laboratory."

In order to explain the nature of this laboratory, it is worth remembering that nonscience students do not need to learn any particular manipulative skills and are unlikely to have a natural affinity for laboratory work. On the other hand, it is desirable that they acquire some firsthand familiarity with natural phenomena and realize that science deals with more than abstract symbols on a blackboard. Lecture demonstrations, although useful, are not sufficient since they involve students only in a passive and remote way; nor are they suitable for displaying certain phenomena to a large audience. Hence our proposed solution has been to provide a demonstration laboratory, a place where simple equipment is set up which the student can use himself to observe directly some important phenomena. The foremost requirement is that the equipment be both instructive and interesting to the student. The context is somewhat reminiscent of a "museum of science and industry," which is supposed to be enjoyable and attractive to the general population. The difference is that the demonstration laboratory is an informal situation where the equipment is in the open so that the student can play with it to his heart's content, and where there is present a teaching assistant who can answer questions or make suggestions. No formal requirements exist which would force a student to process data or write up any reports. The equipment exists as a learning aid to the student and provides a setting where he may be stimulated to raise questions and test his understanding; its purpose is *not* to provide a rigidly fixed assignment which must be accomplished. In short, the teaching assistant should not be a slave to the equipment nor should he feel compelled to make students perform certain manipulations according to some prescribed time schedule. He should rather be master of the situation, free to use the available equipment to foster maximum learning and interest on the part of his students.

The success of the demonstration laboratories depends greatly on a very careful selection of the experiments that are set up and on the skill of the teaching assistant. Those experiments are best which illustrate fundamental concepts directly and vividly in as simple a manner as possible. Equipment that is too fancy may often be more of a hindrance than a help by making phenomena seem remote, complicated, and unnatural. Accordingly, it also follows that the cost of setting up demonstration laboratories for large numbers of students (600 in our case) is relatively low.

Cooperative Course

Our educational goal of getting students actively involved in the course can only be achieved with the aid of an adequate number of able teaching assistants. We therefore made an effort to use teaching assistants more effectively than is customarily the case in the university. First, we select the teaching assistants quite carefully, interviewing every one personally before offering him a position. Then we proceed to establish a close working relation with the group of about 15 teaching assistants in the course. The assistants attend the lectures by the professor and get together with him in a weekly staff meeting. This meeting provides the opportunity for mutual exchange of ideas and assumes, at times, the format of a seminar. Thus the professor outlines his teaching plans for the subsequent week, gives some general instructions to the assistants, receives suggestions from them, listens to criticisms of his own past performance in lectures, and gets reports about student reactions in the discussion sections. Debate often ensues about what subjects in the course should be emphasized and about the best method of presentation. In general, the teaching assistants are not viewed as mere servants performing various chores on orders by the professor; rather they are considered as teaching faculty who can make valuable contributions and who deserve respect. Even though the roles of the professor and the teaching assistants are distinct, the course is regarded as a cooperative enterprise aimed at providing the best possible education for the students.

Although we have tried to select teaching assistants carefully, we have found no undue difficulty in filling the needed positions. One reason is that the course has several attractive features for an assistant: He is presented with a challenging task that tests his teaching skills in dealing with students who need to be motivated and helped in dealing with fundamental ideas that are new to them; he is given considerable independence in handling discussion sections entrusted to him; and he can expect to broaden his own vistas by virtue of his participation in an interdisciplinary course that transcends his own specialty. Several other factors help in the recruitment of teaching assistants. (i) The interdisciplinary nature of the course allows us to recruit teaching assistants from among the graduate students of several departments. (For example, graduate students in physics, chemistry, and biophysics are all capable of handling a large part of the course.) (ii) We are willing to offer part-time positions requiring at most 10 hours of work per week. In this way we are able to recruit as teaching assistants some advanced graduate students who could not spend much time away from their research pursuits. Yet these students are among the most able and best motivated; many of them volunteer to teach in the course for the sake of the sheer pleasure, challenge, and experience. (iii) We also have experimented (somewhat illegally) with letting an undergraduate act as teaching assistant and have entrusted him with the same duties as other assistants.

This last experiment was quite successful and suggests that undergraduates could be used very effectively as teaching assistants in some college courses. Indeed, it takes only a little reflection to realize the following points: A senior student does not suddenly become much better qualified to teach the moment he obtains his B.A. degree. (There are, in fact, undergraduates who are more competent and better teachers than graduate students.) In addition, since the best graduate students often obtain fellowship support, teaching assistantships tend to be awarded preferentially to the less able graduate students. On the other hand, in choosing teaching assistants from among undergraduates, one can be very selective and pick only the cream of the crop. Finally, undergraduates feel honored by being chosen as assistants, are exceptionally well motivated, and are likely to learn a lot by teaching. Thus I believe that existing university practices which fail to enlist undergraduates as teaching assistants waste valuable talents which could be deployed in a manner beneficial to all concerned.

A course should also provide a sense of cooperation between students and instructors, both in order to enhance student interest in the subject matter and to furnish the instructors with the feedback necessary to assess and modify the course. The small size of the discussion sections encourages effective interaction between students and teaching assistants. Office hours of the assistants are well frequented by students; in addition, assistants have been known to arrange for special informal review sessions (or even to invite students to their homes). Contact between the lecturer and the students is much more difficult to achieve because of the large size of the class. Nevertheless, some steps have been found to be distinctly helpful.

It is obviously benefical if the lecturer makes himself available after his lectures or in office hours. It is even more effective if the lecturer, every week or so, invites students to join him for a bag lunch. Although no more than about 15 students (not always the same) may accept the invitation at any one time, the net result is quite valuable. The atmosphere in the class becomes more intimate despite the large numbers; students become less reluctant to approach the professor if they need help; and the lecturer gets direct feedback from a sample of students and does not need to rely exclusively on feedback coming by way of the teaching assistants. In addition, the lecturing professor can become more responsive to his audience if he can watch the faces of individual students whom he has come to know.

A final word might be said about cooperation between the three professors in charge of the course. The general requirements are that they share a common point of view about the aims of the course, that they keep informed about what each is doing, and that they effect smooth transitions when they transfer main responsibility for the course from one to the other. It is, however, unwise to force people into any prescribed molds. Thus it is best to use great initial care in the selection of the three professors who will cooperate to teach in the course, but then to leave them free to express their own individualistic styles and attitudes.

Assessment

After a preliminary trial with a pilot group, the CNS course went into full-scale operation in the academic year 1966–1967 (*3*). Professors R. C. Strohman (of the department of zoology) and J. E. Hearst (of the department of chemistry) participated with me in the initial development of the course (*4*). Questionnaires were repeatedly used to help in the assessment of student reactions.

How did the students respond to the course? Their comments are instructive and can be briefly summarized as follows:

1) Most students definitely liked the course, although they did not find it easy. Some typical comments were as follows: "Considering that I have disliked science courses in the past, I find this one exciting and enjoyable"; or, "I am more interested in the field than I otherwise would have been and have a greater appreciation of the directions in which science is moving and the tools by which it hopes to achieve progress. I also have a greater appreciation of the scientist as a human being."

2) The students commended the emphasis on fundamental ideas and criticized those instances where we had made the mistake of getting involved in excessive details. Their comments also indicated the need to exercise great care in the choice of suitable homework assignments or collateral reading (such as articles from *Scientific American*). The response to the demonstration laboratories was mixed and again suggested the great importance of selecting experiments very carefully.

3) Enthusiasm and clarity on the part of the lecturer were very much appreciated.

4) The teaching assistants were regarded as being very helpful. Quite a few students stated spontaneously that the teaching assistants in this course had been the best they had encountered in any course at the university and that the whole teaching staff seemed exceptionally concerned with the students and their learning. (It is obvious that our careful selection and use of teaching assistants had proved effective. The remainder of the students' commentaries is rather pathetic; how neglected must students feel at the university if our small amount of care, in the unfavorable context of so large a class, should be so much noted?)

An indication of the reputation acquired by the course is provided by some enrollment figures. In the year after I had finished teaching in the course and no longer participated in it, 1300 students tried to enroll in the course (and 700 of them had to be turned away). In the year afterward, 1100 students tried to enroll (and 500 of them had to be turned away). Since students can satisfy their science requirements by taking other more traditional courses, these figures are likely to be significant.

The reactions of the teaching assistants in the course have also been revealing. Practically all of them have found their teaching experience rewarding and interesting. Many of them also feel that they have learned more about science despite the elementary nature of the course. They have acquired a broader perspective about the principles of their own discipline, have gained greater familiarity with neighboring disciplines, and have come to understand basic concepts much better by being forced to comprehend their essential features without recourse to mathematical formalism. The fact that the teaching assistants learn from the course is a reassuring indication that the course is not devoid of substantive intellectual content, although it is addressed to a lay audience.

Finally, some teaching assistants have posed an interesting question. Why is it, they ask, that in this course for nonscience students an effort is made to point out the way scientists actually work and the mutual influence of science and society, yet such topics are never mentioned in the regular science courses that we have taken. Is it not even more important for us, as future scientists, to be made cognizant of such considerations early in our career? The question is a very good one. Why do we never teach our regular science student anything about science except purely technical subject matter?

Conclusion

The basic conclusion which emerges from our experience is that it is indeed possible to teach significant aspects of modern science to nonscience students and to do so in a manner that is intellectually stimulating, thought-provoking, and interesting to the students. The lack of mathematical sophistication in the students is not a significant obstacle. It is possible to cope reasonably well with the problem of large numbers of students, and the requirements for space and money are quite moderate. The teaching task itself can be appealing since the subject matter deals with topics of fundamental importance and since many of the students, although not prospective scientists, are quite intelligent and receptive to new ideas.

The task of imparting to all students some meaningful perspective about modern science has become increasingly important in our times. Our experience at Berkeley suggests that the task could potentially be achieved quite well despite some inherent difficulties. Indeed, I believe that it could be accomplished much better than we have done if one were to devote more attention and effort to the problem. The fact that a task is important and could be done does not, however, imply that it *will* be done. Improving, or merely sustaining, the quality of a course program of the type we have developed (or preparing new teaching materials for it) requires as the essential ingredient the involvement of good faculty—scientists with a mature perspective of their field, some vision about its role in society, effective teaching skills, and an interest in education. But, since neither universities nor the scientific community offer any particular recognition or other rewards for such educational activities, how realistic is it to hope that first-rate talent can be enlisted to further the goal of making nonexperts more cognizant about contemporary science?

References and Notes

1. Among the exceptions might be mentioned a recent project, rather different in approach from ours, undertaken at Rensselaer Polytechnic Institute under the direction of V. L. Parsegian.
2. After the earlier part of the course has acquainted the students with a background of basic scientific concepts, it is also possible to use as a theme some particular problem, such as photosynthesis or the physiology of vision, whose understanding requires the application of several scientific disciplines in conjunction. Greater exploitation of such problem-centered discussion might well be useful in enhancing the interest of the course.
3. A small grant from the National Science Foundation was helpful in initiating the course and was used predominantly for setting up the demonstration laboratories.
4. Persons involved in the later stages of the course have been Professors W. D. Knight and R. H. Haynes.

NEWS AND COMMENT

Defense Research: Pressure on Social Sciences

Pentagon, under Criticism from Congress, Cuts Back Its Support of Controversial Fieldwork Overseas

The Department of Defense (DOD) —yielding to pressure from a mixed bag of liberals, conservatives, and congressmen eager to curb the "gold flow"—has sharply curtailed its support of social science research overseas. A major goal of the cutback is to avoid further international incidents such as have occurred in recent years because of foreign sensitivities to research sponsored by American military or intelligence agencies.

Over the past several months DOD has taken at least four major steps to withdraw from the controversial overseas research. It has reduced its planned expenditures for such research by more than two-thirds from the level of fiscal year 1968. It has adopted new guidelines intended to restrict the kinds of overseas projects it is willing to support. It has tried to persuade the State Department to assume greater responsibility for foreign area research by offering State $400,000 to get such a program started. And it has proposed the establishment of an interagency committee to determine what foreign area research should be performed and which government agency should support it.

These moves were prompted by increasing, and widespread, criticism of DOD's research effort in the social and behavioral sciences. The Pentagon plans to spend some $48.6 million on such research in fiscal year 1970, up from about $45.4 million in the current fiscal year. Most of this money, which constitutes a relatively small part of the Pentagon's total $8 billion research and development budget, supports research on training techniques, job performance, manpower selection, and other personnel problems of a relatively noncontroversial nature. But a significant portion of the total—about $13.7 million in the current fiscal year —supports research aimed at understanding foreign nations and policy planning studies aimed at developing strategies for dealing with political and military developments around the world. It is these studies with foreign policy implications that have provoked the most controversy, particularly when the studies have involved fieldwork overseas. Most of the foreign area research is actually performed in this country, but somewhat more than $1 million will be spent on data collection abroad in the current fiscal year.

Liberals in Congress, particularly J. William Fulbright, chairman of the Senate Foreign Relations Committee, have criticized Pentagon support of foreign area research on the grounds that DOD has no business meddling in foreign policy and that DOD financing of research overseas has created friction with such countries as Chile, India, and Japan in recent years. On 1 May, Fulbright charged on the Senate floor that Pentagon planners "are busily engaged in blueprinting strategies where our military will play the key role in trying to maintain order in a disordered world." He said many of the research studies "are more likely to lead to additional Vietnams than to a realistic assessment of our proper role in the world."

Conservatives in Congress oppose much of the research on the grounds that it is vague and useless, with little practical application to international problems of defense. Last year Senator John Stennis (D–Miss.), a ranking member of the Armed Services Committee, surprised his colleagues by calling social sciences "the softest spot in all the research and development program." And the Senate Appropriations Committee urged DOD to reduce its social science and foreign area research.

Additional pressures have been exerted on overseas research as a result of efforts, both by the executive branch and by Congress, to curb overseas expenditures in order to stem the flow of gold from this country. There have also been student protests directed at the Pentagon's social science research (see article on page 1039). Moreover, within the defense establishment, many top military men have long derided the social science vogue which swept into the defense department in the early 1960's in line with the late President Kennedy's emphasis on "counter-insurgency" warfare. Admiral Hyman G. Rickover, when asked his opinion of DOD's foreign social science research by the Fulbright committee last year, replied: "No harm would have been