Letters

Teacher Training

Having been involved as a member of the curriculum committee of the State University of New York College of Education at Cortland in a recent revision of our curriculum for the preparation of elementary school teachers, I was interested in the report by John Mayor of the proposals coming from a meeting of representatives of the AAAS and various certification groups from several states [*Science* **131**, 1779 (1960)]. May I suggest that it is an admirable aim to require four courses in mathematics for all prospective elementary teachers, but that this is unrealistic as long as students come to college so poorly prepared in even basic arithmetic, and unreasonable unless the AAAS and other groups concerned in this matter are willing to give wholehearted support to the upgrading of teachers' salaries and professional standing. If our students came to college able to handle the mother tongue and having learned their lessons in basic science, social studies, and so forth, it might be possible to eliminate what is really remedial work in the colleges and thus gain time for teaching these recommended and truly collegiate courses.

It is clear in my mind that we cannot hope to adequately prepare a person to teach in the elementary school in the usual four years of college. If scientists and engineers are born and nurtured in the elementary schools of our land, then elementary school teachers must be ready to play the vital role assigned them. If this requires four courses in mathematics, then it also requires eight courses in science, to say nothing of foreign language, now almost forgotten in the preparation of elementary teachers. Then must come English, speech, music, art, sociology, history, psychology, philosophy, health, political science, and the necessary pedagogical courses. Physical education must not be neglected, and every teacher needs apprentice teaching experience. No college program should eliminate the possibility of electives. What this all adds up to is at least five years of college work, if not more. When this is balanced against potential pay and prestige, is it any wonder our best prospects turn their backs on teaching?

In our curriculum study here each department brought its recommendations for those courses considered essential in the training of elementary school teachers. From this immense total was carved a compromise which would total the 132 semester hours required for graduation. No one is happy with the result, but compromise is the best that can be done. As a liberal-arts college graduate sympathetic to the recent cries against "too much professional education in our teachers colleges," may I say that I believe the 21 hours (equal to seven courses) in pedagogy, including 3 hours in general psychology and 6 hours in human growth and development, which are included in our curriculum are an absolute minimum. The only way that an adequate job can be done is to lengthen the course of study. The recent five-year programs started at some engineering colleges are attempts to cope with the same problem. These are things of which scientists cooperating in these studies must be aware.

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The Scientist's Image of Himself

Gerald Holton rightfully points out [*Science* **131**, 1187 (22 Apr. 1960)] the schism that exists between scientific knowledge and other currents of intellectual thought. Although he suggests that scientists themselves contribute to this schism, his major emphasis is on the image that the public has of science, and of the scientist. I think that the images scientists hold of themselves, and particularly the changes that are evident in their self-representations, also play a very significant role.

I had an opportunity to investigate the self-images of 40 research scientists, men in natural-science fields at academic installations, as one part of a larger psychological study of persons who have selected research science as their vocation. The findings brought out that in some aspects of their identification scientists are caught up in some of the sterotypes about men of science that exist in the public mind. For example, they see themselves as intellectuals, as discoverers of new worlds—worlds which they not only create but in which they then proceed to live. Their work is propelled primarily by pressing "inner" drives; thus, the majority scorn "impure" motivations, such as the desire for recognition, exhibitionism, personal aggrandizement, pragmatic reward, unless these are inescapable concomitants of devotion to the search for truth. Happiness and fulfillment rest primarily in satisfactions at work, with routine, drudgery, administrative duties played down as interferences. In fact, rigor, persistence, and discipline have become institutionalized in their morality code as values in themselves, and the "gentleman scientist" is looked down upon as a laggard who is bound to be unproductive.

It is obvious that such facets of identification emphasize how isolated the researcher is, and how removed from the general cultural pattern. However, he shares many of the elements that would establish bonds between men of science and other intellectuals. Where the break with the intellectual comes is in some of the aspects of identification which are in the process of change, and where some of these most highly stereotyped conceptions about scientists are giving away.

Change in self-image seems to have been most stimulated by the differences that have emerged in the way science is pursued, and the attitudes and values that have accompanied these differences. I shall mention only a few to show the trends of change. For one, the researcher is now shying away from identification with the "great, but maladjusted" or "eccentric" scientist. Reverence for forefathers whose outstanding minds were sometimes housed in odd personalities still exist, yet today's scientists consciously dissociate themselves from peculiar and difficult associates or students, knowing full well that they may be shunting off some very creative workers from their own laboratories. They prefer to depend for their progress on a well-organized, smooth-running, large-scale operation, whose stability demands a minimum of interpersonal relations, especially disturbed ones. Even colleagues who "play expert" in nonscientific fields and attempt to generalize scientific knowledge in relation to cultural problems are frowned upon, and often their scientific work is looked upon retrospectively with suspicion.

Another change comes in the new interest in "putting breakthroughs across." While these men still stress that the main motivation of scientists is the gaining of understanding and knowledge without concern for its immediate application, they feel that the fruits of their searches can be more readily put to good use if they adopt what I have called the skills of "sciencemanship." Some think that success in science and the manipulation of that success are a natural sequence, if one realistically acknowledges that the same motivations which are found in other workers are also present in scientists—such as jealousy, competition, the desire to please a superior.

In general, the new model of science is a corporate one. With this, and its spelling out of all the multiple subparts, budgets, and personnel and administrative matters, comes an increasingly tight definition of what each scientist specifically does at work. This is an important change in the scientist's view of his role, which has characteristically been in part ambiguous and indefinite, hinting at the possibility of multiple choices. Many scientists have

clung to this ambiguity because it seemed to them to mirror some of their attitudes toward the intellectual problems with which they grappled—their dissatisfactions with the obvious and with conventional ways of seeing reality.

It seems to me that these changes in self-image imply that the scientist may be moving outside the intellectual pale and that he thus may remain quite unconcerned with the cultural schism that Holton points out. The "impotence of the modern intellectual" has a counterpart in the impotence of the modern scientist. If the intellectual is moving away from the scientist and the scientist is, at the same time, moving away from the intellectual, the summation would indicate that the two may be drawing apart at an alarming rate.

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Bernice Eiduson's letter is a useful amplification of some points on which I only touched in my article. Because the latter was largely on the image of science and of the scientist in the mind of the literary intellectual, it did not attempt to develop also the interesting problem of the scientist's own image of his work and profession.

There are, I think, at least three good reasons why one should be careful to discuss these problems separately. I cannot develop them here, but I can mention them briefly.

The first point is simply a practical one. Imaginative remedial action is quickly needed on both fronts, but urgency for action is all too often destroyed if each "side" is allowed to make the comfortable mistake of cancelling its obligation by detecting equal needs of reform on the other "side."

Secondly, the two problems are not compatible in an important sense: It is, as Dr. Eiduson implies, bad enough if scientists have an erroneous conception of the nature of science; but it is even worse if this is the case of intellectuals outside science, for we have always depended on the latter to fit science into the total pattern of knowledge. It is not the Newtons who give us Newtonian syntheses but the Voltaires.

Lastly, even at the risk of being widely misunderstood, I feel I must point out that the two problems are unsymmetrical: despite Dr. Eiduson's uncomfortable findings on 40 scientists, the general policy and the tone of scientific work in this country are still being set by men and women who give us far more and far better statesmanship than we might have any right to hope for. Just as in my article I was concerned with the image of science in

the minds of the intellectual leaders to whom the public looks for guidance, I find it significant that among the leading scientific policy makers we still have the quality, insight, and range of concerns of such men as Rabi, Szillard, Oppenheimer, Bronk, Wiesner, Stratton, Kistiakowski, Beadle, Harrison Brown, and Glen Seaborg, to name only a few at random.

Perhaps, however, this hopeful aspect of present scientific leadership is only transitory. These men received their training in the days before the "new science." If the concerns of the new generation of scientists fit those expressed in Dr. Eiduson's sample, one may indeed wonder what will happen when the men and women she studied take the place of our present spokesmen for science.

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Computers and Game-Playing

Since *Science* is intended not only for scientists in general but also for intelligent and interested laymen, it seems unfortunate that Norbert Wiener [*Science* **131**, 1355 (1960)] should have permitted himself to use the jargon of computer specialists without any explanation of the special meanings which accompany this jargon. Wiener discusses checker-playing machines, chess-playing machines, and learning machines, and this may give the impression that these are actual physical embodiments of such abilities. Actually, no such machines exist. Wiener has here followed the practice of discussing a program on a general-purpose computer as though it represented a special-purpose machine which would operate in the manner set forth in the program.

A program is a set of numbers in a certain order, and without human interpretation it remains only that. Undoubtedly a machine could be built which could move checkers and chessmen, but it could only operate on standard-size pieces and could not recognize as chessmen the innumerable pieces of different design which the human player recognizes and moves around quite simply.

It is also possible to play abstract chess, like games in a book, without moving pieces physically; but there are analog relationships in real chess—for example, the emptiness of a line, which is the requirement for movement or castling—which cannot be directly handled by any digital machine. These analog relationships can be approximated digitally by remembering and recalculating the moves of all other