Letters

The Bias toward Research

Few topics can be relied upon to appear so regularly in the Letters pages of *Science* as the neglect of teaching skills in the selection of university faculty. In the latest communication (22 Jan., p. 358), F. T. Worrell lucidly defines the requisites for scholarship which should be demanded of academic personnel and logically argues that an academic scientist may be a scholar without engaging in bench research. I would heartily endorse his thesis that, in theory, a scientist who assiduously studies the literature so as to synthesize the latest scientific thoughts for his students may be superior as a scholar to the bench worker who grinds out unimaginative data. This argument, however, overlooks the operant conditioning of a scientist. In the training of a Ph.D. in science, the main emphasis is on the research thesis. In addition, research training breeds skepticism toward reviews and other secondhand sources as well as a great regard for original research reports. Finally, young scientists are exposed to national professional societies in which research achievement is the *sine qua non* of status and prestige. Why should an individual conditioned to this environment *not* pursue a productive research career?

Three possibilities come to mind. First, he may be the victim of an academic situation where the teaching load is so heavy as to preclude scholarship, either of the bench-research variety or of the literature-synthesis variety. Whatever excellence such an individual may develop in teaching skills, continued exposure to such an environment will suffocate scholarship and reduce him to a reciter of textbooks. A second possibility: he may lack the drive to overcome the frustrations of bench research. The experiments that fail because preconceived hypotheses are wrong or more variables are encountered than the experimental design anticipated, or the experiment completed the day the report appears that someone else has done the same job better, can overwhelm those of faint heart. I doubt whether individuals defeated by these discouragements will show any more persistent dedication to the equally frustrating task of disentangling and synthesizing the many tenuous and contradictory reports that constitute original scientific literature. They will more likely be found in the group described by Worrell "at the faculty club playing bridge." A third category is the group who, once out on their own and removed from the guidance of their mentors, prove incapable of designing successful research. If an individual lacks the intellectual talents to produce creative research in spite of diligent effort, his competence to carry on the type of synthesis Worrell endorses would also appear open to question.

If there is merit in Worrell's argument, we should create a new training environment for academic teachers in which status and prestige are strictly governed by demonstrated ability to carry on the scholarly review of scientific literature which Worrell defends. As he emphatically says, however, this is quite contrary to the present mores of the academic community. That being the case, wisdom dictates that to find the competent products of our current scientific training programs, one must look for the accomplished researcher; it is after this initial screening that we should endeavor to select those who are ready to dedicate themselves to some inspired teaching as well. Worrell's charge that the selection process often stops at the initial screening stage and never proceeds to evaluate teaching abilities may have a distressing element of truth in it; I would emphatically endorse his plea that careful attention should be given to teaching skills in those assigned to academic classrooms. To assure ourselves of competent scholars, however, we must continue to check their bibliographies.

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Desalination and Agriculture

The excellent editorial on desalination of water (18 Dec. 1964, p. 1533) should do much to place in proper perspective the issue of "reclaimed" versus "natural" water supplies. The popular notion that a reduction of desalination costs would turn the arid west into a Garden of Eden must be challenged. If reclaimed salt water were available at no cost at sea level, the pumpage and transportation cost (about 10 cents per 1000 gallons per 100 miles) would prohibit widespread distribution for agricultural purposes. Agriculture now pays only about 1 cent per 1000 gallons for irrigation water.

We must realize that feed, food, and fiber for future generations will have to be produced in areas of our country (and the world) where soil moisture is renewed annually by natural precipitation. Future developments in desalination methods may reduce such water costs so that they will not be prohibitive for human and industrial uses, but certainly they will remain prohibitive for agricultural uses except for very specialized crops.

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Solar Astronomy Neglected

In the report of the Whitford Committee, *Ground-Based Astronomy, a Ten-Year Program* (National Academy of Sciences, Washington, D.C.), a distinguished group of stellar and radio astronomers has recommended a vigorous program in stellar and radio astronomy (*Science*, 13 Nov. 1964, p. 899; 25 Dec. 1964, p. 1641). We wish to point out that there is a third important branch of astronomy, not represented in the committee and barely mentioned in the report, namely, solar astronomy. Despite the obvious importance of the study of the sun, our nearest and best known star, the 105-page report devotes only one paragraph to problems of the advancement of solar astronomy.

We believe that all fields of astronomy are exciting and important and deserve national attention. This is particularly true of solar astronomy, because of the profound practical influences of the sun, as well as its exciting scientific aspects. Not enough is known

about solar flares, solar activity in general, surface and atmospheric magnetic fields, and the important solar-terrestrial relations. Better understanding of all these is critical for the national space effort as well as other endeavors, including stellar and radio astronomy.

We do not wish to represent ourselves as spokesmen for solar astronomy, but, since that field has had no representation on the committee, we should like to suggest several directions for the national effort in solar astronomy which would help satisfy critical needs. In our opinion three important points are: graduate teaching, construction of medium-size instruments, and site testing.

1) There is only one full program training Ph.D.'s in solar astronomy today; two other schools train some of their students in more modest programs. Many graduate schools teach no courses in solar astronomy at all. We daily receive requests for Ph.D.'s in solar astronomy which we simply cannot fill. The space program has made especially heavy demands on our meager supply of solar astronomers.

2) There is a particular need in solar astronomy for instruments in the 10- to 15-inch aperture class, both for research and instruction. Not one such instrument has been built in the United States since 1954.

3) A good observing site is of particular importance for solar astronomy because of the extreme variability of daytime seeing. No existing solar observatory has been located as a result of an exhaustive site survey; the Kitt Peak National Observatory, for instance, was chosen as the result of a hunt for a site for night-time observations. Great rewards would certainly be realized from a thorough search for an ideal solar observatory site.

We hope that the virtual absence of comment on solar astronomy in the Whitford Report will not impede efforts to solve such problems.

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The members of the Panel on Astronomical Facilities had hoped that its report would stir up vigorous discussion, both among working astronomers and among university and government administrators. The foregoing letter may therefore be welcomed as a very proper statement of one group's position that the needs of solar astronomy were slighted in the report. I should like to point out, however, that the lack of positive recommendations regarding solar astronomy was not entirely the result of the makeup of the panel or its insensitivity to the needs of this sector of the astronomical community. The solar astronomer who was a member of the Committee on Science and Public Policy of the National Academy of Sciences, which established the panel, met with the group during the sessions when the basic positions were formulated. In the spring of 1963 the panel addressed a letter to every member of the American Astronomical Society inviting comments on new developments in ground-based astronomy and statements as to needed facilities. The response from solar astronomers in the United States was remarkably small and included no letters from the members of the Pasadena group which now thinks there is a clear need for instruments to meet the current upsurge of interest.

The panel was aware that any 10-year blueprint would be out of date in some respects on the day it was published, and that unforeseen developments would inevitably call for review or revision within two to five years. If other solar astronomers in the United States join the authors of the foregoing letter in the opinion that there is a case for support of instrumentation beyond the major facilities just completed or under construction (mentioned on page 39 of the report), it is to be hoped that some mechanism can be found for the formulation of a comprehensive statement to the scientific community setting forth current new directions in solar astronomy, the intrinsic interest of this field of research, and its relation to other branches of astronomy, physics, and geophysics.

Finally it may be pointed out that the solar astronomers suddenly required by the nation's space effort cannot be generated simply by the granting of funds to universities to build instruments for solar research. Such instruments will come into being as a result of the specifically expressed needs of active groups of university-connected solar astronomers whose current research is already attracting the interest of graduate students.

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