tional processes, and use it as feedback to help students self-actualize. I think we should also be aware that poor grades often reflect instructional, as well as student, deficiences. But let us not mislead ourselves and students by stating that college evaluation, even as presently conducted, is worthless when it comes to predicting success in later years.

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References

1. D. P. Hoyt, *ACT Res. Rep. No. 7* (American College Testing Program, Iowa City, Iowa, Sept. 1965).
2. M. H. Oden, *Genet. Psychol. Monogr.* **77**, 3 (1968).
3. C. W. Taylor and R. L. Ellison, *Science* **155**, 1075 (1967).

Arsenic and Phosphate: Measured by Various Techniques

It was interesting to note (*1*) that the Soap and Detergent Association and the enzyme manufacturers took Angino *et al.* (*2*) to task for what they seemed to regard as an irresponsible discussion of the occurrence of arsenic. . . . Now that the subject has been brought up I would like to add our experiences. We, too, have been finding arsenic in waters—in lake waters to be exact. In ten Minnesota lakes the concentrations of arsenic found in filtered surface waters taken in the fall were 7, 9, 11, 16, 22, 36, 105, 132, 216, and 224 μg/liter, respectively. The last four are well above the Public Health Service's limit for drinking water, but as lakes are not considered drinking water these days I have refrained from calling public attention to these figures. Indeed I have gone out of my way when asked about them to point out that they probably are not harmful. In this way I suspect more has been gained in peace of mind than has been lost in toxicity. (I do not mean to imply that if we close our eyes our problems will go away. On the contrary I believe we should keep our eyes and minds open, but perhaps our mouths shut, until we know what we are saying.) However, these numbers *are* very important for a different reason than health. Most investigators interested in lake pollution are measuring phosphate by some modification of the so-called Harvey method: usually by a molybdate–stannous chloride procedure. This procedure does not distinguish between phosphate and arsenate (the form in which most of the arsenic is present) and so many measurements are undoubtedly wrong in studies where arsenic is present at the concentrations we find. In fact, to give an example, the lake having an arsenic concentration of 224 μg/liter had a concentration of phosphate, by the Harvey procedure, of 104 μg/liter, but a bioassay showed the concentration of phosphate to be less than 1 μg/liter. Clearly if we hope to correlate algal growth with phosphate concentrations or fluxes we must do better. Some investigators who use the so-called Stephens technique may avoid the error somewhat but even this technique is not completely free of arsenate interference. I would recommend that those engaged in measurements of phosphate in lakes be aware of the problem and if it exists try the method we have found that completely eliminates the interference (*3*).

The source of the arsenate is probably from its addition to lakes as sodium arsenite to kill rooted aquatic plants. In Minnesota, records show that from 1956 to 1969 over 900,000 pounds of the chemical were applied. In New York State, from 1961 to 1966, about 85,000 pounds were used and it is likely that even greater quantities have been spread about in other states. The arsenite rapidly oxidizes to arsenate and, because of its relatively low involvement in biological processes, seems to have a long half-life.

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References

1. E. S. Pattison, *Science* **170**, 870 (1970); I. V. Sollins, *ibid.*, p. 871.
2. E. E. Angino, L. M. Magnuson, T. C. Waugh, O. K. Galle, J. Bredfeldt, *ibid.* **168**, 389 (1970).
3. W. Chamberlain and J. Shapiro, *Limnol. Oceanogr.* **14**, 921 (1969).

Doctor of Arts Degree

In his editorial (6 Nov., p. 586) H. Guyford Stever suggests that the rationale behind the Doctor of Arts degree is to fill a gap between the more research-oriented universities and the secondary institutions, the state and junior colleges. It is primarily to these institutions that students would go for training as teachers and it is these institutions that would be expected to absorb the holders of the new degree. I take exception to Stever's contention that new degrees must be created to meet existing needs. What society, including the academic community, needs is not a new degree but rather stronger Ph.D. and master's degrees which prepare candidates to teach *and* carry on significant original research.

Individuals trained primarily in methodology of instruction are generally poorly prepared to effectively convey the excitement of discovery and creativity unless they have been active participants in original investigations. The best college instructors are those who are engaged in a balanced program of instruction and research. Parenthetically, the ability to critically read literature in a field is greatly enhanced by involvement in original research, and such an ability is an essential part of the educational process.

While the new degree might theoretically solve some of the problems of state and junor colleges, it would do absolutely nothing to solve the problem of the university instructor who must be engaged in original research as well as an effective teaching program. At a time when public support of original research is diminishing and the research-oriented Ph.D. is being placed in a classroom and asked to produce or to seek a position elsewhere, it is even more imperative that Ph.D.'s, who are trained at a great deal of expense, have the preparation and training to be effective instructors as well as effective researchers. One cannot and should not separate teaching from research.

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I trust that physical and biological scientists will not support the Doctor of Arts program proposed by Stever which bypasses the candidate who is discovering new knowledge in his field. Instead the candidate evolves teaching materials and strategies and "develops evaluating instruments, and tests his material in class. The work is carried out in the major-subject department. . . ."

I suggest that the candidates who choose this route are even less likely to be equipped to work in this area of the behavioral sciences. Developing reliable, valid, and unbiased evaluating instruments to assess students' behavior is a challenging technical task. There are standards for data and observations in the behavioral sciences that need to be met. Furthermore, to test instructional processes and curricula in classrooms requires sophisticated behavioral science research designs involving protection against internal and external validity threats atypical to the physical sciences.

There are scientific questions that should be answered, however, concerning the effectiveness of instructional methods and curricula in the "hard" sciences. For instance, why should physical or biological science courses be required of students in the secondary schools, in college, and often included in the lower grades? Is it to learn the elementary facts and principles of a science, or scientific method, thinking habits, and attitudes? Yet even physical and biological research scientists evaluating science curricula often make quite unscientific statements with little regard to the quality of the behavioral science data. Can those who choose not to discover new knowledge in their own fields do research in another?

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It will not be easy to change the pattern of earning advanced degrees in the sciences. As of March 1970, only three institutions, including Carnegie-Mellon, were granting the Doctor of Arts degree and only one of those offered it in the sciences (University of North Dakota). The problem is one of acceptability; the degree is not marketable in science departments for a variety of reasons and especially in the buyer's academic marketplace.

A study last year by the Commission on Undergraduate Education in the Biological Sciences revealed considerable interest in programs aimed toward improving college teaching. Some distinguished, strongly research-oriented biology departments are modifying the Ph.D. program to permit research on curricular innovation in lieu of the traditional thesis. Of more immediate consequence are the expanding programs to improve training for teaching assistants. Nearly 70 percent of all Ph.D.'s in biology become college teachers and only 10 percent publish 90 percent of the research papers. Thus, the time is long overdue for alternatives within the Ph.D. program to prepare scientists for teaching—the job which most of them choose.

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