

perplexing that the education school refuses to consider that the low number of hours in biology might be a hindrance to the development of quality teachers in that discipline. From my personal perspective, the fact that education majors take fewer hours than other biology majors is appalling. Yet, because of outside factors, we are powerless to do anything substantial about it.

Finally, I want to address a subject about education programs that is often ignored in these discussions. It is something that has puzzled me ever since my undergraduate days at Rutgers in the 1970s. Whenever I discuss education courses or curriculum with education students, no matter what university I am at, I always get the same response from the students—that their courses are mostly a waste of time, have little worth with regards to content, and that they hate (not my word, but the students' word) most of the courses required to be a teacher. Why is this so? I've seen it at Rutgers, at Georgia, and now here at Appalachian State. Is it student naivete? Probably not. I don't hear other students lambast their majors as much as education students do. Rather, I think the fault lies with the education schools themselves. Perhaps an overemphasis on theory, rather than practice, coupled with a failure to come up with material that is stimulating, leads to rejection and boredom on the part of the students. Alternatively, if education attracts students with lesser abilities, and there is some evidence that it does, course contents may be down-regulated to the extent that the talented students in education are deprived of the stimuli needed to challenge and attract them to the profession.

If a school of education can't devise a curriculum that interests their own students, that is intellectually challenging, and is regarded as useful by the students, how can we feel confident about their ability to teach the teachers? It makes me wonder why we have schools of education in the first place, and why so much emphasis is on classroom instruction, and not in-the-class experience. The only course that does routinely receive favorable reviews seems to be student teaching. Why not expand on that finding and reduce classroom study? Experience would seem to be the best teacher in this case.

I end by acknowledging that the situation is complex, and that the sad state regarding secondary teaching is not the sole province of schools of

education. But somewhere along this line of failure something must change. Why can't the universities be among the first to acknowledge the situation, and why can't they be among the first to change? Just think what might happen when you actually know "what" you are trying teach!

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Dear Editor:

I have enjoyed the debate concerning your January 1994 editorial about teaching science. I have taught biology at the secondary school level for 27 years. I consider myself an educator whose interest is in biology. I have my masters in biology, not education. The vast majority of my valuable education training has been done through seminars and conventions while I have been teaching. In reading the letters to the editor, I have several comments to make.

To William F. McComas, I would like to say back off. Read what you wrote and think about the job of an editor. I have never heard of an editor, in any format, who has to have peer review of his editorials. An editorial is an opinion, not scientific research. Good editorials stimulate public debate that results in discussion, information and changes beneficial to all.

To Randy Moore, keep up the good work, even though there are times that I don't agree with you.

To Susan Cameron and all other interested biology teachers, there is a summer masters program tailored for your needs at Emporia State University, Emporia, Kansas. I earned my masters in biology in four summers taking courses in field biology, microbiology genetics, human physiology, research design and analysis, fresh water ecology, prairie ecology, research problems, and others. All were geared to learning basic science knowledge but much was applicable to my teaching. Kansas is "The Land of Ahs" (not Oz), despite the rumors that it is just a place to drive through. Write the university's biology department for a brochure; it is exactly what you are looking for except that it is 1500 miles west of Boston.

Finally, I'll add my opinion to the debate. In any subject like this there is too much in the way of politics (whose philosophy wins the favor of the university president) and money (which department will get the bulk of the

money). From a high school teacher's point of view, I would advise prospective teachers to get an undergraduate degree in a subject area. Then get an internship with a working teacher while taking "more relevant" education courses from a university (closer to the secondary school if not located close enough to the home university) for another year. This student should be paid as a parateacher, which would help defray the costs of the university classes for the last year of the program. This student would experience teaching as it truly is and the veteran teacher would benefit from more modern information on the subject, as well as teaching help and the enthusiasm of the younger person. This program must not be a cop-out for the veteran to dump the work on the apprentice either to get more "free time" or become a "better coach." A program like this could develop into a win-win for all concerned. Could the paradigm be shifted in such a way that all parties are benefited?

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Who's Accountable?

Dear Editor:

In your January 1994 editorial you added your voice to those pointing at a problem of great concern to many in science education: How do we best train elementary education teachers to teach science? The American school system has a unique quality that sometimes impedes informed discussion. It is the system's seeming simplicity that promotes misunderstanding. Within the system of schools, things aren't what they first seem. To the casual observer the panda appears to be related to the brown bear, the peccary appears related to the pig, or high grades appear related to successful life accomplishments. But, as with our educational system, when the details of each are investigated, the perceived relationships are found not to be there.

Your proposal was to eliminate departments of education and to have students take only content courses from the science departments. The education departments teach pedagogy—how to teach—but this is done only after the students have learned subject content from the appropriate departments as university and education department prerequisites. When we look

at the science courses elementary education majors already take, we find that most take biology. So why is biology not the best taught subject in elementary schools?

This system of university science courses has placed the teacher hopefuls in large introductory biology classes that have at most one advantage: They are cost-effective for the science departments. Shelia Tobias (1990) showed that students were being turned off to science in these introductory classes. David Hestenes (Hestenes, Wells & Swackhamer 1992) discovered that students in introductory courses, despite passing paper and pencil tests, may excel in plug-and-chugging, but not in understanding.

Furthermore, this approach places teacher hopefuls in a subsystem to learn science from professors who get slight or no rewards in terms of tenure, promotion or recognition for excellent teaching. So the elementary education majors and their nonscience counterparts from other departments leave the class firm in their original misconceptions: that plants eat dirt, photosynthesis is a respiratory process, and oxygen turns into carbon dioxide in the lungs.

Where in the elementary education major's school career, beyond a methods course, do they see models of how hands-on science should be taught? Most large scale introductory science labs are laden with cookbook activities. The most successful student in the cooking classes is the one who can follow the directions, not present or solve problems. The sole interactions of the lab teammates are to "divide and conquer" to finish assignments within the allotted 60 minutes. The science curriculum in most introduction courses is the textbook which is lectured to them by a science professor.

With the wrong role models we ask teachers to teach science the way the scientists teach it. And, sadly, the elementary teachers do. They only repeat what they have seen in their science courses: plug and chug, memorize the formula, and answer the problems at the end of the chapter. So when we assign accountability for poor quality teaching, we must also look at the science departments' part in educating teachers.

The education of teachers must be a community effort. Lee Shulman (1987) has shown that content alone, or pedagogy alone, does not make effective teachers. If the knowledge of content were the only factor in making an

exemplary teacher, our research scientists would be our best teachers. But this is not true. If pedagogy were enough, the Sumerhill experience and the open classroom would have worked. But it couldn't stand alone.

What are some of the positive things that biology departments can do to help train elementary education majors? The biology departments need to reward their professors for quality science teaching so that there is equal status for a professor who wants to devote his or her career to teaching. Departments need to direct the science content towards understanding for nonscience majors classes, not the content we have always taught "just because it always was." The economic reality is that departments must rely on teaching assistants, but these people need to be trained and rewarded for pedagogy. Content-specific classes need to be provided for elementary education majors. And finally, the best biology students need to be advised to go into teaching, not the ones we whisper "will never make it as a biologist."

References

- Hestenes, D., Wells, M. & Swackhamer, G. (1992). Force concept inventory. *The Physics Teacher*, 30, 141-166.
- Tobias, S. (1990). They're not dumb, they're different. Tucson, AZ: Research Corporation.
- Shulman, L.W. (1987). Knowledge and teaching: Foundation of the new reform. *Harvard Education Review*, 57(1), 1-22.

Operation Physics Clarified

Dear Editor:

Thank you for printing the letter by Anthony J. Husemann regarding Operation Physics in your May issue. Although we appreciate Mr. Husemann's enthusiastic opinion of Operation Physics, his letter contains two minor errors.

First, Operation Physics is a program of the American Institute of Physics, funded in part by the National Science Foundation. Although Mr. Husemann refers to AIP as "the National Science Foundation's American Institute of Physics," AIP is an independent scientific association and not a subsidiary or peripheral organization of the NSF.

Second, the American Institute of Physics has relocated, and our new

address is: Operation Physics, One Physics Ellipse, College Park, MD 20740-3843, (301) 209-3008, (301) 209-0839 (fax).

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Animal Use Policy Sparks Debate

Dear Editor:

I have just received the February, 1994 issue of *News & Views* and am delighted with the NABT Position Statement, "The Use of Animals in Biology Education" that appears on page 14. It is far superior to anything on that subject that has come out of NABT previously. I commend the Board of Directors and am glad to see the Statement published and made available for all who are interested.

It is not quite a perfect statement, however. Let's paraphrase the fourth paragraph using a history class that has a student in it who hates, actually detests, memorization of dates. She says to her teacher that she'd like a substitute for memorizing dates. After all, she says, the history teachers' "association encourages teachers to be sensitive to substantive student objections to memorization and to consider providing appropriate alternatives for those students."

The teacher replies that he feels that the memorization of dates is a fundamental part of his course and that the history teachers' association "acknowledges that no alternative can substitute for the actual experience of memorization and urges teachers to be aware of the limitations of alternatives."

I agree with the teacher. He has properly preferred, for sound pedagogical reasons, the sentence he selected from the fourth paragraph over the one selected by the student. I think the teacher finds the sentence selected by the student to be a contradiction and a meaningless sop to kids who don't like to memorize dates.

To jump to the bottom line: Leave the Statement as is. We live in a multicultural society and what we have is probably the best that can be obtained in that society.

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