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ABSTRACT

The University of Arkansas at Monticello's 1985 Summer Science Institute was created to improve competence in science among on-the-job upper elementary school teachers (grades 4-6) in southeast Arkansas. Students received three weeks of solid introductory coursework in botany, chemistry, and geology. However, deficiencies in public school science education are extensive and deeply rooted and will not be seriously addressed by anything less than radical changes in teacher training and certification policies.

INTRODUCTION

The Teacher Education Improvement Consortium was organized and funded in 1984 by the Arkansas Department of Higher Education to address the problem of declining student achievement in science at the elementary and secondary levels. Three goals were identified:

1) to improve the scientific and mathematical competence of existing teachers, K-12;
2) to improve the professional attitudes and esprit de corps of existing teachers, K-12; and
3) to identify model teaching techniques from the institutes and in-services (see below) and disseminate that information.

The Consortium's action took the form of four Summer Science Institutes located on the four University of Arkansas campuses. The Institutes offered education in the sciences to elementary and secondary teachers, who in turn were to pass along what they had learned both to their students, and, later, to their colleagues in a series of "in-service peer-teaching" workshops.

In its analysis of science education at the secondary level, the Teacher Education Improvement Consortium (Goal Statement, unpublished document, distributed by TEIC, 1984) attributed declining student achievement, in part, to an excess of academic democracy:

> Secondary school curricula have become homogenized, diluted and diffuse. With extensive student choice, students do not opt for the more rigorous classes in science and mathematics.

The problem of course begins in the lower grades (if not at home). A National Science Foundation study, published in 1978 (The Status of Pre-College Science, Mathematics, and Social Studies Educational Practices in U.S. Schools: an Overview and Summaries of Three Studies, Washington, D.C.: U.S. Government Printing Office), gave the following dire description of elementary science education in America:

> Although we found a few elementary teachers with a strong interest and understanding of science, the number was insufficient to suggest that even half the nation's youngsters would have a single elementary school year in which their teacher could give science a substantial share of the curriculum and do a good job of teaching it.

And most recently, a study by the Southern Regional Education Board's Commission for Educational Quality (Improving Teacher Education: an Agenda for Higher Education and the Schools, SREB: Atlanta, 1985) placed the responsibility for inadequate teaching, in part, on teacher education programs. That report bears the general message: more content, less pedagogy.

> Elementary teachers should be broadly educated across all of the major academic divisions...They need breadth in their academic preparation. If they are to develop as scholars, they also need to delve into some academic subjects more deeply than they are likely to do if they limit themselves mostly to introductory courses.

That the inadequate teacher salaries offered by a tight-fisted and skeptical to simply apathetic public might be the principal cause of the disease and the unsatisfactory performance of many students, teachers, and teacher educators merely symptoms is too large an issue to take up here.

THE UAM SUMMER SCIENCE INSTITUTE

Faculty from UAM and the regional public schools, as well as representatives from the Southeast Arkansas Educational Cooperative, meeting as a Local Advisory Committee, chose to concentrate efforts on science teaching at the upper elementary level. In UAM's Summer Science Institute, 23 fourth through sixth grade teachers were given three weeks of introductory science coursework by three UAM faculty in their areas of expertise: biology (mostly botany), chemistry, and earth science or geology. Each subject received a week's treatment. Students attended lecture-laboratory sessions 6 hours a day, 5 days a week. During the academic year subsequent to the Summer Institute, each teacher was to present two "in-service" workshops to his or her colleagues at the local schools.

One of the most attractive features of the Science Institute grant was its generous budget. Local school teachers were recognized as professionals and received an honorarium of 500 dollars each. Additional funds permitted the purchase and distribution of supplies and lab materials. Teachers returned to their classrooms with books on the trees and wildflowers of Arkansas, mounted specimens of native trees, rocks, and minerals, and an assortment of common chemicals and chemistry glassware and small lab equipment. Several travelling chemistry boxes were stocked with pH meters, small electronic balances, and battery chargers, to be circulated among interested area science teachers by the Southeast Arkansas Educational Cooperative.

A syllabus summarizing science content of the UAM phase of the Institute is given below:

BIOLOGY/BOTANY:

Day 1: Scientific method; aims and methods of taxonomy; artificial and natural classification systems; construction of dichotomous keys.

Day 2: Observation, description, and drawing of flowering plant vegetative parts; identification of local trees; setting up a lab practical examination.
Day 3: Observation, drawing, and description of flowering plant reproductive parts (flowers); pollination biology; wildflower identification.
Day 4: Wildflower identification (continued) and specimen preparation; structure and dispersal of fruits and seeds; seed germination.
Day 5: Flora and vegetation; habitats, plant communities and biomes; field trip to Warren Prairie, a unique saline soil prairie in southeast Arkansas.

CHEMISTRY:
Day 1: Elements, simple substances, and their properties.
Day 2: Chemical reactions.
Day 3: Acids and bases.
Day 4: Solutions and electrolytes.
Day 5: Gases, polymers, crystals; miscellaneous topics.

EARTH SCIENCE:
Day 1: Earth materials; properties of minerals.
Day 2: Rock cycles—igneous and metamorphic rocks.
Day 3: Sedimentary rocks.
Day 4: Fossilization and fossils.
Day 5: Field trip to Hot Springs area to collect minerals, rocks and fossils.

Teachers stuck closely to this schedule, and students received a solid introduction to the three disciplines.

CONCLUSIONS

Based on observations of in-service peer-teaching workshops, Institute faculty have concluded that one week is insufficient to provide the student with a core of knowledge from which to draw upon in the creation of educational science activities. The majority of in-service lessons observed has been superficial and, occasionally, misinformed. Upper elementary teachers and their students would have been better served by a concentrated three week course in a single scientific discipline.

Even more appropriate, I believe, would have been a more or less standard undergraduate introductory lab science course, perhaps modified for the upper elementary teaching major and open to post-baccalaureate teachers as well. I will repeat here an assertion from the Teacher Education Improvement Consortium's Goal Statement: "With extensive student choice, (high school) students do not opt for the more rigorous classes in science and mathematics." If we would have high school students take three rigorous science courses, why should we not demand the same of college students preparing for careers in upper elementary teaching? On the job, in grades 4-6, they will teach science from 3 to 5 days a week, unless they make a deliberate effort to avoid the subject.

It appears to me that we must equip at least upper elementary teachers with some degree of expertise in science. Whether we would have elementary science specialists or simply elementary teachers with a solid background in the sciences, the most straightforward way to have either *on a permanent basis* in our public schools would be to bring certain education students into the mainstream of undergraduate science preparation. The Southern Regional Education Board (1985) calls for elementary education students "to take some courses in academic disciplines at the upper level. Completion of an academic major is another way in which some elementary teachers, especially those who will teach older children, might obtain more depth in the undergraduate subject matter preparation."

One such academic program would be a 36 credit hour major in General Science with only a minor in Elementary Education. As elementary school science teachers, graduates would be comfortable enough with the processes of science to emphasize method rather than content alone, and knowledgeable and flexible enough to supplement the textbook with personal observations and local materials.

Although professional scientists might debate the proportions of biology, chemistry, geology, and physics in such a General Science major, I would suspect the proposal, in general, to meet with their approval. Why is there, then, no such emphasis on science content in elementary teacher training programs? Among several possible answers to a complex question, I would emphasize one: elementary teachers are certified to teach kindergarten through sixth grade, or first through sixth grade, or reading, or special education. No distinction is made between math and science and the language arts nor even between upper and lower elementary. Thus a teacher who has taken one 3-hour lecture course in biology, a physical science for elementary teachers course, and one or two other non-lab, general science classes to fulfill General Education requirements is considered qualified to teach science not only to four and five year old children but to twelve year olds as well. In this regard, the seven years of astounding intellectual growth, undergone by a child between kindergarten and sixth grade, is not reflected in elementary teacher education programs nor in certification procedures. Obviously, such ill-prepared and, in certain instances, disinterested elementary teachers can as easily stifle scientific curiosity as foster it.

State laws govern the certification of teachers. They are enacted by the Arkansas General Assembly and enforced by the Arkansas State Department of Education. They derive largely from the recommendations of public school and college teachers and administrators. I would strongly recommend consideration of the implementation of a single teaching certificate in upper elementary and junior high science and math.

I in no way wish to belittle the accomplishments of the UAM Summer Science Institute when I suggest that post-baccalaureate science training for upper elementary teachers be modeled after the science program here proposed for undergraduates. To teach good science, most teachers need to be exposed to the standard science coursework of the college curriculum. Three week mini-courses and science institutes may be politically desirable at certain times, but they carry serious drawbacks: they are administrative headaches; they are often sinecures in which the grading scale starts at B; and they are academically second best to real laboratory science courses.