PRESERVICE TEACHER EDUCATION: ALIVE AND WELL AT TWO-YEAR COLLEGES

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Collaboration, creativity, communication and change. These four words describe the foundation for reform efforts in mathematics and science nationwide. These words also describe the foundation for reform in preservice teacher education programs in the state of Delaware.

Collaboration

Several years ago, faculty from three branches of postsecondary education, Delaware Technical and Community College (DTCC), the University of Delaware (UD), and Delaware State University (DSU), banded together to discuss the need for reform in the mathematics and science preparation of elementary and middle school teachers graduating from their respective colleges. It was generally agreed that the mathematics and science course work required for preservice teachers was insufficient in terms of credit hours, organization, and alignment with reform standards for teacher preparation.

One often hears of the chasms dividing two-year and four-year colleges, their difference in student bodies, faculty attitudes, and opinions. In our situation, working with volunteers from DTCC, UD, and DSU interested in reform, we found a delightful group of hard working, creative, and like-minded individuals. Eventually application for funding for proposed initiatives was made to the National Science Foundation and funding was granted (DISCUS: Delaware's Innovative Science/Math Collaboration for Undergraduate Success). At the community college level the money NSF provided allowed our collaborative group to participate in training activities and to purchase materials and manipulatives for our new courses (Mathematics for Elementary Teachers I and II). The DISCUS initiative at the three schools supported substantial reform or revision of 15 courses.

The Mathematics for Elementary Teachers courses at Delaware Technical and

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Community College were written upon the foundations of the NCTM and AMATYC mathematical standards. These courses include alternative methods of assessment, team teaching, group learning projects and hands-on activities that give students experience with manipulatives as they receive instruction in topics that include probability, geometry, statistics and technology. These courses have been articulated with four year institutions within the state.

One of the mechanisms for change was the introduction of "Big Projects" to a total of eight courses in areas of biology (UD), chemistry (DTCC), and physical science (DSU and UD). The courses which use Big Projects are rather varied. "Quarks, Gluons, and the Big Bang" at the University of Delaware is a course on particle physics addressed to general audiences–students who are not specializing in science. Students are given data on elementary particles and are asked to discover the underlying symmetries. They analyze results and "publish papers" for other students in the class electronically. The other UD astronomy course, "Earth in Space", which uses Big Projects is a summer course taught to in-service teachers. Teachers have to complete an observational or research investigation and also report on the classroom application of the astronomy they have learned in the class.

One of the biology courses which uses big projects is "Introductory Biology", a large, multi-sectioned course at UD taught in lecture by several different instructors and in laboratory by a lab coordinator and an ever-changing squadron of laboratory instructors. Students experiment with the life cycle of an organism over periods of several weeks. Experiments with Wisconsin Fast Plants, a very rapid growing strain of *Brassica rapa*, test the effects of different levels of pH, salt contamination, or amounts of fertilizer on plant growth. Collaborations between mathematics, physics, and biology faculty are exploring ways in which statistical techniques can be used to assess the results. Students in "Human Anatomy and Physiology" assess the effects of various stimulants (often caffeine) on various aspects of human physiology such as heart rate and respiration rate, using other students in the class as subjects.

Two physical science courses taken by preservice elementary school teachers have been transformed in ways that are slightly different, because the courses are different. "Physical Science and Technology" at UD resembles introductory biology in that it is a multi-

sectioned course required of all pre-service elementary teachers. A dozen or so TA's lead the laboratories, and each year most of the TA's are new to the course. For four weeks, students work in teams of 4-5 to design and conduct their own experimental investigation. The results are presented initially to their laboratory section, and selected teams then present the results to the campus in a poster session. The "Physical Science Survey" (27-201) course at Delaware State University is unified by a number of "great ideas" and includes several teaching strategies, including design activities which extend over several classes [1].

Other reformed courses include "Black Holes and Cosmic Evolution", (UD), a course taught by a single faculty member to a roomful of 340 students. In about 1/3 to 1/2 of the classes, students do group work. While the group work is often pencil-and-paper analyses of graphs and texts, occasionally they do mini-labs in a lecture room. This course has been extensively evaluated by a team of faculty and graduate students from the University of Delaware school of education, working with the course instructor who teaches in the physics and astronomy department. "Earth Science" at DSU is a required course for prospective teachers that includes three cooperative problems that students solve as a group as well as activities which require students to find out information on their own using the Internet. As a result of the collaboration, faculty have shared ideas and laboratory exercises, thereby encouraging and sustaining the development of student-centered, inquiry-based learning activities at all three institutions.

Creativity

As our courses developed, our enthusiasm grew and so did our imagination. Additional projects and training were developed at Delaware Tech, the University of Delaware and Delaware State concurrently. A local school district allowed three instructors from Delaware Tech to participate in inservice training activities for K-6 grade teachers. Our preservice mathematics content courses at Delaware Tech became "hands-on" and "minds-on". The students now work their way through math content in probability, statistics, geometry, measurement, algebra, and other topics while experiencing the variety of methods and assessment measures proposed by reform documents nationally. Student response to the course work at all schools has been consistently positive and unanimous in praise.

The NSF funding enabled instructors at the community college to incorporate most

of our reform concepts. The purchasing of manipulatives, books that link mathematics with literature, measuring devices, and reference documents allowed us to complete our lending library. In addition to the extensive demonstration and use of these materials in class, the materials are also checked out to education majors at Delaware Tech for use during their student teaching practicum.

National documents on reform speak to the need to incorporate technology into preservice classrooms. Research at two-year colleges indicates that while over ninety percent of preservice teacher mathematics courses incorporate calculators, less than forty-five percent incorporate computer training [2]. Students at DTCC use the Internet to search for standards-based lesson plans that are then presented as a part of their mathematics classes. Students in these preservice classes communicate with faculty through the campus e-mail system, open to all who register for classes at the college.

Communication

With the recent funding of the second phase of our state-wide collaboration (IMSTEP - Integrating Math and Science in Teacher Education Programs) we will be able to begin our community outreach program. Mini-seminars will be offered to area day care workers, Head Start staff, education majors at the area colleges, and elementary school teachers in the Wilmington area. These programs will demonstrate mathematics and science lessons for preschool and elementary school teachers in an interdisciplinary format. All after-school sessions will include mathematics and science standards and will hopefully forge a strong link between our college and the inner-city community.

The children of Delaware will ultimately benefit as the materials of reform are absorbed into classrooms statewide. Opportunities that our children will have to experience, enjoy, converse, and achieve in areas of math and science are essential for student success. We plan to provide these opportunities. Team teaching across departments at DTCC, UD and DSU will be a part of this second phase as well.

Communication standards are at the heart of the national reform effort. Mathematics anxiety is a palpable component of preservice teacher education. Students with fine preparation in mathematics seem also to carry the burden of this anxiety. It is a high priority

for faculty at DTCC to address this problem directly, and diminish students' fears through the use of a variety of instructional styles and assessment measures.

Recently, a student, Connie, was asked to share her answer to a problem in class; Connie said she believed the answer to be fourteen square centimeters. I asked Connie to explain to me how she had arrived at that answer. How sad it was to see her erasing the answer on her paper. I assured her the answer was correct and that she shouldn't be erasing an answer so nicely computed. Connie replied, "You know, I was sure my answer was wrong. Every time someone has asked me to explain my answers, it was because my answer was wrong." Clearly, past experiences in mathematics are often negative and vividly remembered by our students.

Group discovery sessions, hands-on experiences with math manipulatives, and the opportunity to defend and describe mathematical conjectures are all a part of a standards-based preservice teachers course. Students have a vast experiential base in individual isolation within mathematics classes. Discussing, supposing, writing and defending mathematical ideas is a totally new experience for most of the students we teach in our preservice teachers course. Faculty teaching these courses must nurture a spirit of inquiry and must use the same instructional techniques in their classes that the prospective teachers will be expected to use [3].

Change

What is it like to teach these future teachers? It is exhilarating, exciting and exhausting. It takes much longer to prepare these high-activity, fast moving classes than one would imagine, unless one has already taught at the elementary school level. It is also a wonderful experience and we would not have missed it for the world.

The following anecdote demonstrates the change that we have accomplished in a short time: One of the early childhood education adjunct instructors presented an activity in which he gave his methods class a pile of assorted objects (chopsticks, rubber balls, milk gallon caps, etc.). The introduction given was, "You are working at a day care and there is no budget for materials. What kind of lesson plans can you come up with using these objects?" As the students started offering idea after idea in rapid succession, the instructor wrote down their

ideas. He was amazed. "Last year," he said, "the students offered no ideas in mathematics and science. This year, you came up with seventeen. What happened?" The student response was, "Let us tell you about our new math classes!"

The proposed science course for preservice teachers at Delaware Tech will focus on three major questions: (1) What is the nature of science? (2) What is the nature of matter? (3) What can science tell us about the human body? This course is in the early stages of development but the goal is to develop student-centered, inquiry-based activities that integrate science and mathematics. The mathematics will become less abstract and the science more understandable.

In the area of preservice training, it is generally accepted that most teachers teach as they were taught [4], [5]. Assuming this to be true, it is crucial that courses taught to prospective elementary school teachers in mathematics be taught using topics and methods identified in reform documents [6]. In the preface from *A Call for Change* [7], the challenge is clearly stated for those who teach preservice teachers.

In order for teachers to implement the curriculum envisioned by the NCTM Standards, they must have opportunities in their collegiate courses to do mathematics, explore, analyze, construct models, collect and represent data, present arguments, and solve problems. The content of collegiate level courses must reflect the changes in emphasis and content of the emerging school curriculum and the rapidly broadening scope of mathematics itself.

Although much progress has been made, concerns still exist over the future of reform coursework. Collaboration between institutions allows for meaningful changes to be implemented. However, collaboration within and between institutions often moves at a slow pace. Resistance to change is a mighty force, perhaps the single most importance force affecting standards reform.

It has been said that the only person truly ready for change is a wet, messy, baby. Not true! America's two-year colleges are ready to start on the changes that will enable our preservice teacher population to enrich classrooms with the knowledge and enthusiasm they have gained in reform based classes. ■

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