Preparing Math and Science Teachers to Use Technology

By Ann Shore, Cheryl Mason, Gini Pedersen and Barbara Armstrong

The State of California recently mandated that teachers must demonstrate certain minimum computer-related skills and abilities before being granted a clear teaching credential. In compliance with this mandate, San Diego State University's Department of Educational Technology offers a series of courses and test-out procedures which allow teachers to gain the necessary skills to meet the state's mandate for computer competency.

In order to encourage teacher educators to extend and expand their use of technology in methods instruction, we embarked on a collaborative venture between the School of Teacher Education and the Department of Educational Technology. Our efforts were aimed specifically at the enhanced delivery of science and mathematics instruction. We formed a team, consisting of a mathematics methods instructor, a science methods instructor (content specialists), and an educational technology instructor. We also had the support and expertise of two graduate assistants enrolled in the Educational Technology Master's degree program.

The vehicle chosen for the implementation of our cooperative effort was a series of courses emphasizing the teaching of mathematics and science. The two pilot courses were restricted to teachers of K-12 grades who had already fulfilled the state minimum computer competencies either by completing the educational technology courses or by passing the challenge tests. The intent of these courses was not to teach teachers how to use computers and related technologies, but to demonstrate how instruction and learning in specific content areas (mathematics and sciences) could be enhanced through the appropriate use of technologies.

Faculty Background

Criteria for participation in this project included educational background and expertise, a willingness to rethink the relationship between technologies and content instruction, and a dedication to a project which demanded an investment of both time and energy.

The science content specialist has earned undergraduate and master's degrees in science, with a Ph.D. in science education and educational computing. Her instructional experience includes teaching science and computer literacy (12 years) at the middle and high school levels, and biology (3 years) and science methods (6 years) at the university level. Throughout this time, she used a variety of technological tools (mainly Apple II's and videotapes) to enhance her teaching and student learning.

The mathematics content specialist has earned her undergraduate and graduate degrees in education and has a Ph.D. in mathematics education. She taught at the elementary and middle school level for 16 years. Currently she is teaching undergraduate and graduate level courses in mathematics education. She has also provided inservice mathematics education to practicing teachers. Her most extensive experience with computers has been for personal use and the development of computer literacy for students at the primary level.

The educational technology specialist has an Ed.D. in Curriculum and Instruction, specializing in instructional technology. She has taught at the elementary school level for 17 years and educational technology courses at the university level for two years. In addition, she has used computer technologies as instructional tools in the elementary classroom for five years and has provided a variety of computer-use workshops for adults.

Development of a Common Language and Understanding

The main intent of our project was for the content specialists to learn how to enhance the delivery of specific content areas by integrating instructional technology within the curriculum. The content specialists were already comfortable with the uses of various technologies. This was an opportunity for them to experience current uses of technology for classroom instruction. It was criti-

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cally important that, as a result of this project, the content specialists would be able to internalize the rationale that content drives technology—not the other way around. Specifically, technology should be used to implement, support, supplement, and enhance instruction—not supplant it.

The first step in the process involved a series of organizational strategy meetings scheduled over several months and chaired by the educational technology specialist. These meetings provided a forum for the discussion and sharing of educational philosophies, ideas about learning theory, and concerns about the use of technology in the classroom.

To serve as part of the learning and role-modeling environment and to enable us to be more effective, technology was always available for use as a tool. Since the organizational sessions were so lively and productive, we audiotaped them to record the ongoing evolution of our merging philosophies and to free us from the time-consuming and distracting task of note-taking. On other occasions we capitalized on the functional assets of a computer and immediately recorded our thoughts and ideas as we brainstormed aloud.

During earlier sessions the majority of the time was spent spontaneously airing our various views on the use of technology to enhance student learning. These discussions stimulated us to articulate ideas that we had held over time about the use of technology to enhance content learning and teaching, while providing a vehicle for the clarification of our thoughts.

Even though the mathematics and science teacher educators had verbalized the belief that the subject matter to be taught was of primary importance, there was an initial tendency to ask what new developments in technology were available for classroom use. The solution (delivery system) was being sought before the goals and objectives had been identified. Eventually, instead of asking what could be taught with specific hardware or software, there was a focus on how delivery of specific content could be improved by matching objectives and instructional intent with appropriate technology.

Through subsequent discussions, we were able to concentrate on the development of the pilot course content as we recognize that our basic philosophies were very similar albeit from different perspectives. A common understanding held throughout was that computer technology could be a powerful tool for the enhancement of instruction and learning; however, improper use of technology could be detrimental to instructional goals and outcomes.

By the end of the organizational meetings there was a fusion of philosophies and perspectives as to how technology could be integrated within the curricula of mathematics and science. The combined resources, strengths, interests, and backgrounds resulted in a catalytic and synergistic interaction among participants. The final outcome was that the content specialists learned effective ways to employ technology in their teaching, and the educational technology specialist was better able to detail specifically how technology could enhance the teaching and learning of mathematics and science.

**Pilot Course Development**

Since the courses were one unit each, 16 hours of class sessions were available. As indicated previously, the courses were open to teachers of K-12 grades. So not only were the topic areas (mathematics and science) extremely broad, we were also dealing with diverse student populations. It was essential to the successful delivery of these two courses that the focus of each course not only be well defined, but also be broad enough to encompass the wide range of abilities and interests we expected to encounter.

For inclusion in the course, the content specialists targeted only a few of the key themes or strands identified by mathematics and science national organizations—National Council of Teachers of Mathematics (NCTM) and National Science Teachers Association (NSTA). The science course emphasized the areas of student preconceptions and misconceptions, theme-based curriculum with interdisciplinary approaches, careers, and underrepresented groups. The mathematics course focused on three strands: concept development, skill acquisition, and problem solving.

Once the focus and the objectives for each course were defined, the graduate assistants, with the aid of the educational technology specialist, developed a matrix onto which to classify relevant software. The next action was to identify appropriate software and hardware—no small task given the grade levels and content areas involved. We sought to develop content-specific data bases which included standard computer software, CD-ROM, videotapes, and videodiscs. A variety of resources were used, but the most helpful were the State of California’s Technology in the Curriculum (TIC) guides for mathematics and science. Although these guides dealt only with computer software and videotapes, they served as an excellent starting point by identifying companies who consistently produced exemplary materials.

Each of these targeted companies was contacted to discover what mathematics and science materials were available and/or currently being developed, and to ask if they would be willing to loan us copies for use in our courses. In conjunction with that effort, the graduate assistants and the educational technology specialist explored other options available for delivery including CD-ROM, videodiscs, and audiotapes.

We endeavored to provide examples of technology for each content strand and grade level. Additional meetings were held with each of the content specialists, the graduate assistants, and the educational technologist to identify specific software packages for demonstration in the courses.

**Course content.** Although the educational technology specialist presented options and assisted in the selection of both technological exemplars and non-examples for course use, each course sylla-