THE USE OF PROJECT-BASED LEARNING IN A TECHNOLOGY COURSE FOR MATH AND SCIENCE TEACHERS

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In this project, pre- and in-service math and science teachers used project-based learning to learn the complex skills involved in integrating technology into math and science teaching. The teachers in the course *E36.1002: Microcomputer Applications in Math and Science Instruction* in the Department of Teaching & Learning at New York University developed a four-week curriculum that integrates math, science, and technology using a common theme chosen by the teachers. The program has received very positive feedback from all participants and may be expanded in the future. Some recommendations are provided on how field experience in teaching with technology can be integrated into math and science teacher education programs.

Introduction

The Milken Foundation commissioned the International Society for Technology in Education [1,2] to carry out a survey entitled, " Information Technology in Teacher Education." The survey involved 416 institutions that graduate 90,000 students per year. According to the survey, over 70% of teacher education programs require students to take a three-credit course in instructional technology. However, most teacher education faculty do not believe that this is preparing teachers to effectively use technology in their classrooms. The report states that the number of instructional technology (IT) courses taken is not as important as practical, hands-on experience in the use of technology in actual teaching situations. A critical deficiency in the programs that do offer technology training is that field experiences are not provided. This project, with financial support from the New York Collaborative for Excellence in Teacher Preparation (NYCETP), has developed a model in which practical, hands-on experience in the integration of technology in math and science teaching is enmeshed with an instructional technology course for math and science teachers.

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The Summer High School Math, Science, Technology (MST) Program

The Summer High School Program was originally run by the Academic Computer Facility at New York University to give students experience in computer science related fields. The program was then turned over to the School of Education. The advent of the NYCETP Project provided a perfect opportunity to focus the Summer Program on Math, Science, and Technology (MST). University students who had completed and excelled in the course *E36,1002: Microcomputer Applications in Math and Science Instruction* were selected as NYCETP Teaching Scholars and then asked to develop and implement the Summer MST program.

For the past four years, the model has worked very well, and the summer MST program has been designed by NYCETP Teaching Scholars working with other pre- and in-service math and science teachers. This program is open to high school students and their teachers from New York City public schools.

The main goals of the *Microcomputer Applications in Math and Science Instruction* course are to help math and science teachers become technologically literate and to enable them to learn how to use technology to enhance their teaching. One of the course requirements is to carry out a group project, and each semester a group contributes to the design of a summer MST curriculum. The teachers are asked to design a curriculum that meets the following requirements:

1) Complete lesson plans need to be designed and placed on the web for a 9 am to 5 pm, 5 day per week, four-week program for a group of forty to fifty students and six to ten teachers.
2) The program should involve hands-on inquiry learning of math and science, with a variety of learning experiences, including field trips, and work in science labs.
3) High school students will learn how to use technology tools, such as word processors, spreadsheets, databases, and the web in math and science learning tasks.
4) Math, science, and technology should be seamlessly integrated under a common theme. Activities should include physics, chemistry, biology, earth science, and mathematics.

5) All activities should be linked to the relevant New York State Regents syllabi and National Science Education Standards.

The Course - Microcomputer Applications in Math and Science Instruction

The teachers in the "Micro" course have a wide variety of technology skills and teaching experience when they enter the class. Some are very skillful while others have never used a mouse; some are experienced teachers while others have never set foot in a classroom. The use of projects and a web-based course allows the teachers to proceed at their own speed through the various activities, and to learn technology skills in a non-threatening environment. Project-based learning has been used at many different levels as a means of helping students acquire higher order thinking skills [3,4,5]. This paper will focus on just one of the many projects carried out by the teachers, the summer high school MST program that has been partially supported by NYCETP.

Designing a High School Summer Math, Science, Technology Program

The "Micro" course, and past summer programs, are models that the teachers used to design the curriculum. Last year's course outline can be seen at the following URL: http://www.nyu.edu/classes/murfin/index.html. Past summer programs can be seen on the web at the following URL: http://www.nyu.edu/education/scied/summermst/. In most cases, the sequence of technology activities designed by the teachers for the summer MST program closely parallels the sequence of activities in the course the teachers are taking themselves. The task of creating the curriculum is a very complex one requiring not only technological skill, but also pedagogical content knowledge [6] in math and in the various sciences. In order to facilitate this, a large, heterogeneous group of pre- and in-service teachers work on the project over the course of three semesters. Each semester, the summer MST group usually consists of from 3 to 6 teachers, both pre-and in-service, math and science. The project is a cumulative one, where the group in each succeeding semester builds on the work of the previous group. The use of the web pages and a web board creates the social memory that makes this possible. The NYCETP Teaching Scholars then complete the final development of the curriculum and carry out the actual instruction.

Teaching Math and Science With Technology

However, there is a world of difference in designing the program and actually teaching it to high school students. Most of the NYCETP Teaching Scholar instructors in

the summer MST program are pre-service math and science teachers. In-service teachers usually have other commitments during the summer, such as teaching summer school. Every year, a computer science student is also hired, and he or she serves as the "techie" for the team of instructors. The Teaching Scholars, who work on the curriculum and teach it, come out of the experience with very strong technology skills and a very good idea of how they can best integrate technology into their own teaching. Extensive data was collected during the 1999 summer MST program. The high school students completed a pre- and post-technology survey from online forms used to evaluate each day's activities. All of this information went directly into an online database that was accessible to all of the instructors of the summer MST program.

It is very interesting how similar the group of pre-service teachers was to the group of high school students who participated in the summer MST program. The pre-service teachers used strategies and pedagogical techniques with the high school students that were almost identical to those that were used to "teach the teachers" in the Micro class. This has very important implications for teacher educators who integrate technology into their courses.

The high school students, just like their teachers, also had very different experiences with technology and some have much stronger math and science backgrounds than others. In order to deal with this tremendous diversity in the group of high school students, a large number of instructors were provided so that students could receive individual attention. The emphasis on group work also facilitated peer tutoring [7]. In many cases, a student can get a difficult idea across to fellow students far more quickly and effectively than an adult can.

Results

The feedback from the high school students, their teachers, and the summer MST instructors has been very positive. One concrete measure of the NYCETP Teaching Scholar instructors' success is the quality of the work created by the high school students. Each year of the summer MST program, the high school students' research projects have become more rigorous and more focused on math and science. The high school student research projects from the 1999 Summer MST program can be seen at the following URL: http://www.nyu.edu/projects/summermst99/groupprojects/index.html. A promising trend was noted, in that the teachers and students are now focusing more on using

technology to learn math and science rather than learning technology for its own sake. In previous summer programs, both students and instructors were initially dazzled by the power technology put at their disposal. As a result, one could observe teachers and students spending hours playing with scanned images of themselves, popular sports figures, or music personalities. There was a constant struggle by the university professor to bring the focus of the activities back to math and science. Novice users of technology tend to be overwhelmed by all the effort needed just to learn how to use the software, and the reason for learning how to use the tool, i.e., to help learn math and science, is quickly forgotten. It is essential that teachers put technology in its proper place, as a tool that is no more important than any other tool that helps students learn.

The NYCETP Teaching Scholar instructors work together as a multidisciplinary team to prepare for the lessons by dividing up the work and, in effect, teaching each other. The actual teaching takes place in a very supportive environment, a well-equipped computer lab at the university. There are a large number of other pre-service teachers in the room, along with a small number of experienced teachers from public schools who also attend the summer MST programs with groups of high school students. Each summer, the summer curriculum is put together, but it is never complete beforehand. The workload on the instructors is very demanding and the Teaching Scholar instructors experience first hand the demands placed on teachers. The instructors especially underestimate the amount of preparation needed to conduct a successful lesson. This is where the university professor plays an important role, continually making suggestions, giving feedback, and ensuring the quality of the lessons before they are taught.

One difficulty that emerged was that there is a discontinuity when different persons design and teach the curriculum. Here again, the university professor needs to provide the link between the two. The cumulative model of developing the curriculum over three semesters has weaknesses, but it does allow the pre-service teachers to tackle a large, complex project that would never be possible for one group of pre-service teachers to complete in one semester.

Conclusions

The NYCETP Teaching Scholar instructors' experience in the summer MST program has been an effective introduction to the practical world of teaching with technology. Each instructor receives extensive experience in working with the whole

class and also interacting with individual students. Teaching the summer MST program results in more effective learning than designing the curriculum. Those students, the Teaching Scholars, who both taught and designed curriculum, stood out from the other instructors as a result of their exemplary work. Some of these teachers eventually became technology "experts" in their schools.

Recommendations

Future plans include having all lesson plans entered into an online database in a common format. This will help ensure quality of the lesson designs and also make the lesson plans more accessible to other teachers. A similar summer MST program for middle school students is also being considered. Opportunities to integrate field experiences with technology into the Secondary Science Methods course are also being investigated. One means of doing this might be in the development of an after-school Math, Science, Technology program in partnership with local public schools.

In any event, it is essential that more practical field experiences in the use of technology in teaching be provided to all teachers. These field experiences must involve teaching in a math and/or science context, in order to integrate technology skills into the pedagogical content knowledge of the teachers. The teaching of general instructional technology techniques in isolation from the teachers' content areas is not recommended. It is vital that all teacher educators, regardless of subject or specialty areas, become proficient in the use of technology in teaching if these valuable skills are going to be acquired by future generations of teachers. ■

Bio

Brian Murfin completed his Ph.D. in Science Education at Ohio State University. He is presently Assistant Professor of Science Education in the Department of Teaching & Learning, School of Education, New York University. His research interests are technology in science education.

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