

INTEGRATION OF TECHNOLOGY IN MATH AND SCIENCE EDUCATION— A MODEL FOR TEACHING ELEMENTARY AND MIDDLE SCHOOL PRE- SERVICE TEACHERS

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Abstract

This paper describes the development and implementation of a course, *Integration of Technology in Math and Science Education*, to introduce elementary and middle school pre-service teachers to real technology skills that they can use in their future classrooms. Activities allowed the students to learn technology skills while using the Internet to enrich their content skills and share information with their fellow students. The course was designed to allow students to master a variety of technology skills, and see how these skills can be used appropriately in their future classrooms, while also increasing their comfort level to use the technology and reduce their resistance and anxiety to use it later in their real-time classrooms. During the class hands-on activities, the students became fluent at using the Internet for enrichment and communication, and at developing strategies for using their new skills to present SOL-relevant lesson plans. Students enter this course with very little in the way of educational technology skills, but leave with a teaching “toolbox” filled with new skills.

Rationale

A course was developed to introduce elementary and middle school pre-service teachers to various new types of classroom technology and show them how to integrate these technologies into their math and science curricula. The importance of such a course is emphasized in the current literature [1-5]. The course, *Integration of Technology in Math and Science Education*, was initially developed with support from the Virginia Collaborative for Excellence in the Preparation of Teachers (VCEPT) in the Spring 2001 semester by the Department of Biology at Virginia Commonwealth University (VCU) in Richmond, Virginia. The course was further developed and modified for the Spring 2002 semester with support from a U.S. Department of Education PT3 grant awarded to the VCU School of Education, with the author as project director.

In today’s society, the constant infiltration of advanced technology is no longer a new idea, but more of an expectation [6]. Wireless phones can now double as digital cameras or MP3 players, while nanotechnology is making possible the creation of next-generation computer

processors which utilize DNA molecules. E-mail attachments and personal pagers are mere afterthoughts in a world where creativity is the limiting reagent of endless possibilities. One underlying goal of this course was to introduce our elementary and middle school pre-service teachers to the brave new world of technology in the classroom. Most present elementary and many middle school teachers were not math or science majors in college and most elementary pre-service teachers do not major in math or science; of the 32 students that have taken our course, none has been a math or science major. This fact has led us to three major objectives: 1) teach our elementary and middle school pre-service teachers specific technology skills that they can master and apply in their future classrooms; 2) teach them how these technology skills can be used appropriately; and, 3) help increase the comfort level or decrease the anxiety level for using these technologies to help as they bring the wonders of math and science to their students.

Course Design

The first several meetings of the course are used to discuss the research process and to present a good orientation to science, and the critical thinking and problem solving approach. The current educational technology literature emphasizes the importance of these thinking skills [7,8]. Research is defined as an activity of data collection, evaluation, and presentation. We distinguish between descriptive and hypothesis-based research and emphasize that both are needed to add new data to the existing science database. We define both the dependent and independent variables and develop hands-on projects that allow the students to formulate null hypotheses and test for significant differences in the data sets collected. We introduce GraphPad's *InStat* program with which they conduct both descriptive (means, medians, modes) and hypothesis testing (parametric and nonparametric) data analyses.

We also spend time discussing the components of experimental design and the basics of research planning. They learn how to collect data sets carefully and accurately, and record these data in well designed research laboratory notebooks. We emphasize the importance of running experiments in replicate and in repeating runs a number of times before drawing conclusions.

As the course continues, the students are introduced to a variety of web-based tools that can be used to assist them as teachers and enrich their content knowledge (see Appendix A). These activities are centered around *BlackBoard*, a web-based course management software program. The class is divided into small work/task groups of 3-4 students. Students learn how to

use e-mail and Internet forums to transfer and share data. They learn how to search the Internet (often using *Google*) for enrichment materials and then share these via the Internet with their group and/or the entire class. These activities introduce the students to the concept of student-centered classrooms with which they can experiment later in their future classrooms [9]. Individual students also learn how to use *BlackBoard* to prepare their own personal web pages and share these with the class. In addition, they learn how to use the Virginia Science Resource Network (VSRN) to contact math, science, and technology experts that have joined the VSRN as mentors.

As student groups start collecting data, they begin to learn how to use *Microsoft Excel* to organize and evaluate their data sets. They also use the *InStat* program for statistical analysis, and learn how to move data between these two programs and out to the *BlackBoard* website. Completed data sets are then graphically formatted using GraphPad's *Prism* program, and prepared for group presentation using Microsoft's *PowerPoint*. As the students complete these activities, they become very skilled with the technology and are ready for more complex experiences.

The remainder of the semester is dedicated to hands-on activities. We start with several simple dataset generation activities involving fruit fly mutation analysis, and lettuce seed germination and seedling growth characteristics. With the fruit fly, they run several hybrid crosses and use chi-square analysis to help identify patterns of appearance of phenotypes. With the lettuce, they collect descriptive data on germination (%) and also calculate average root and hypocotyls growth rates. These data sets are evaluated using the software and protocols learned earlier in the course and then prepared for presentation.

As the semester continues, the student groups work in three-week cycles. During Week 1, they are introduced to a new technology skill. During Week 2, they perfect the skill and use it to collect data. During Week 3, they present their findings to the rest of the class, both via the Internet and also by real-time seminars. A variety of skills are approached using this format in addition to using a number of computer assisted data acquisition probes.

In the beginning of the three-week cycles, the students learn how to run DNA gel electrophoresis equipment and also the Intel Play QX3 Computer Microscope. They then go through a series of activities using PASCO data acquisition probes including PASCO's hand-held

device called the “Xplorer.” The Xplorer can be used to collect data at remote sites and it can then be downloaded later to a computer for analysis and presentation. After working with the Xplorer, they learn how to use a variety of PASCO probes including probes for temperature, pH, sound, heart rate, motion, light sensor, and voltage. In the final weeks of the course, they use several probes in combination, such as the temperature probe with the pH probe to look for temperature changes during titration experiments, or the voltage probe with the light sensor to see the relationship between voltage and the amount of light generated from a filament. These activities not only introduce them to new technology, but with Internet enrichment searches, allow them to expand their content learning.

Group Product Outputs

With each three-week cycle, each group of students reinforces their data acquisition, evaluation, and presentation skills and becomes more comfortable with the process. Groups are monitored carefully to make sure all students are appropriately engaged in the activities. During the second week of the cycle involving probeware; the groups are free to design their own specific experiments.

During their presentations during Week 3, they have to present three basic components:

- list some very good interactive websites that could enrich their activity;
- develop strategies for using their technology to introduce specific Virginia Standards of Learning (SOL) for math, science and/or technology;
- describe in detail specific relevant lesson plans that they could use in their future classrooms.

Students found some really good sites including: one on writing reports (www.ncsu.edu/labwrite); one for enrichment (<http://sciencespot.net/Pages/kdzbio.html>); and, one for self-training (www.freescills.com). In addition to the third week requirements for each cycle, the students have two additional final product requirements: 1) a detailed three-ring binder filled with descriptions of all their activities, websites, SOL links, lesson plans, and notes which they take with them; and, 2) a final Grand Symposium production. During the Grand Symposium, they invite faculty and other persons from all of the math and science departments at VCU, in addition to interested faculty from the VCU School of Education, to come for an afternoon of

sharing. Each group prepares several hands-on activities and shares them with the symposium visitors.

With each activity, we discuss how the various technologies they learn could be integrated into their math and science lesson plans. We also discuss how the math and science lesson plans themselves could be integrated and effectively presented to their future elementary and middle school students.

Conclusion — Impact on Students

Students were continually monitored throughout the course. Informal group and individual interviews were conducted by Fisher and Ha. The overall goal of the course was to introduce the students to a variety of technology-based skills and help them discover how these new tools could be integrated into their math and science curricula. Students were assessed, by interview, during the first class meeting to determine skill and comfort levels for using basic classroom technologies in the areas of electronic media: e-mail, Internet, forums, web pages, *BlackBoard*, *Google*, and the VSRN. They were also assessed in the area of computer-based data acquisition and data presentation protocols including: *Microsoft Word*, *Excel*, and *PowerPoint*; *Instat* and *Prism*; computer-based probeware, such as those developed by PASCO; and, the PC QX3 microscope. They were also asked if they were familiar with any of the new DNA technologies, such as DNA gel electrophoresis.

The results from these initial interviews were somewhat surprising, but maybe not unexpected in a group of mainly non-math and science majors. Basically, the students had little or no skills in the above listed areas. Some had basic skills with the Internet, e-mail and *Microsoft Word* and a little exposure to *Excel*, but no real exposure to the other skills we planned to cover.

Similar assessments were made as the semester progressed and new skills were introduced. At the end of the semester, students were interviewed to collect information on exit attitudes. All students reported increases in their technology skills in all the areas presented. In addition, most students felt much more comfortable with these new skills and felt ready to use them in their future classrooms. We conclude that our approach works and could be tried with other groups of future teachers who are not math or science majors.

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APPENDIX A

Blackboard: a course management software program — <http://blackboard.com/>

Free Skills: free online tutorials for a variety of software —
<http://www.freescills.com/>

Google: a great search engine — <http://www.google.com/>

GraphPad: a site to download simple to use statistics and graphics programs —
<http://www.graphpad.com/welcome.htm>

Intel's QX3 microscope: very nice learning site for the QX3 microscope —
<http://micro.magnet.fsu.edu/optics/intelplay/>

Lab Write: great site for data logging and evaluation protocols —
<http://www.ncsu.edu/labwrite/>

PASCO: computer probeware company — <http://www.pasco.com/>

Science Spot: great links for enrichment sites —
<http://sciencespot.net/Pages/kdzbio.html>

Virginia Science Resource Network: a site that can link to expert mentors —
<http://www.vsm.org/>