

TRAINING IN-SERVICE AND PRE-SERVICE TEACHERS
IN THE USE OF TECHNOLOGY

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One of the most exciting changes in the teaching of mathematics has been brought about by advances in technology and by the availability of technology in colleges and high schools. This is possible because of the relatively low cost of calculators and computers and the availability of grants to purchase equipment. There are six important areas where technology has taken great strides in the past few years:

1. Relatively inexpensive graphics calculators, that can radically change how algebra and trigonometry courses are taught, are now available to nearly everyone. Schools throughout the country are requiring or are purchasing graphics calculators for use in algebra and trigonometry courses. Graphics calculators are required on some college admission tests, such as the AP Calculus Test. The popularity of graphics calculators in high schools is evidenced by the large number of requests our department has received to offer in-service training in the use of graphics calculators, and by the large turnout of teachers who attended a graphics calculator workshop offered at Georgia Southern.
2. Computer programs illustrating the concepts of geometry, such as Geometer's Sketchpad, are available with prices low enough for all schools to purchase at least a demonstration program for the teacher. We have recently received an Eisenhower Grant to teach the use of Geometer's Sketchpad to in-service teachers.
3. Computer Algebra Systems such as Derive, Mathematica, and Maple are becoming more popular in high school calculus courses, and some graphics calculators with symbolic manipulation are now being used in high schools.
4. Computer spreadsheet programs are becoming widely available with new computers. Teachers can use spreadsheets to help manage their classrooms as well as solve mathematics problems.
5. The Internet is becoming more widely available in high school classrooms and in high school students' homes. Students are eager to use the Web as a reference source rather than use a book.
6. Distance Learning makes it possible to bring the power of educational experts to every corner of the country. This technology is especially useful in training teachers how to use other technology without requiring the teachers to leave their school districts.

These developments create unique challenges for the current high school mathematics teachers and to future mathematics teachers. It is of course desirable for all mathematics teachers to be aware of the possible uses of technology and for them to be able to integrate them into their courses.

Many high school mathematics teachers have had little or no training in the use of technology. Although much of the current technology is relatively easy to use, many teachers are not using any technology or are not using technology as efficiently as possible.

We have found that many pre-service teachers did not recognize the need for certain technology in their teaching until they have become in-service teachers. They then have the task of learning how to use the technology by themselves because they no longer have access to the facilities of the University. This learning is inefficient and often incomplete, so they are not as effective as teachers as they could be.

Our mission at Georgia Southern was to prepare in-service teachers to teach in a high school environment that contains one or more of these technologies, and to prepare future teachers to use these technologies before they enter the profession.

Georgia Southern does much to prepare future mathematics teachers in the use of technology, because it is using all of these forms of technology in its mathematics courses. Graphics calculators are used in most of the college algebra and trigonometry courses, and the Geometer's Sketchpad is being used in geometry courses. All calculus courses are taught with a Mathematica lab. One computer science course, Computer Management for Teachers, teaches the use of word processing, spreadsheets, data management, and programming, while a second teaches computer programming.

A problem arises because many of our mathematics education majors have not taken algebra and trigonometry at Georgia Southern; this is because they began their course of study with calculus, which uses Mathematica. Therefore, they have no experience with graphics calculators, which is most likely the technology that they will be asked to use when they begin to teach high school mathematics. In addition, using geometry software and computer algebra systems as students in mathematics courses does not necessarily prepare them to use the technology as teachers in high school.

Our solution to this problem was to offer a new course, TECHNOLOGY IN MATHEMATICS. It is expected that at the completion of this course, students will be able to:

1. Use a graphics calculator.

Students learn to use most of the capabilities of a graphics calculator, including graphing, modeling various types of equations from real data, matrix operations, and optimization. They are taught the advantages of using a graphics approach to algebra, trigonometry, and calculus. In addition, they are given practice leading a group in the use of a graphics calculator in the solution of mathematical problems.

2. Use Geometer's Sketchpad.

Few in-service teachers have used Geometer's Sketchpad, and few pre-service teachers have thought about how they can use it as a teacher rather than as a student. They are asked to develop innovative uses for the program and to demonstrate the effectiveness of their ideas.

3. Use Mathematica or another computer algebra system.

The goal is for students to compare the power of a computer algebra system such as Mathematica with that of a graphics calculator, and to determine when the use of a computer algebra system is preferable to other technology. The emphasis is on the use of Mathematica to teach concepts, and on its advantages in testing ideas and concepts.

4. Use computer spreadsheets.

Students are asked to solve applied problems and to generalize solutions found with other technology by using a computer spreadsheet.

5. Use email for communication and the World Wide Web to access information.

Rather than use reference books to find formulas and ideas, they are encouraged to use the information infrastructure. It is hoped that they will see the value of using this new source of information in their mathematics classes.

6. Decide which technology is most appropriate to solve a given problem.

Students are expected to determine what technology or technologies will be most effective in solving a given problem. It is hoped that they will see the value each type of technology.

Cooperative learning is used to solve real data and applied problems in this course. Pre-service and in-service teachers can benefit from the use of cooperative learning as students in this course, and they can learn how effective cooperative learning can be their classrooms. It is hoped that this course will be a model of cooperative learning for them to use with their students.

The course is designed to pose applied/real data problems and to challenge students to choose the appropriate technology to solve the problem. Each student is expected to become an expert in some technology and to be a leader in the use of the chosen technology to solve a problem. A similar problem or an extension of the problem is then given as an individual assignment.

The course is a mathematics course. It is not taught as a "how to teach" course or as a "how to" course, but as a mathematical applications course in which part of the problem being solved is how to choose the appropriate technology and how to use it. This approach could only be successful in a cooperative learning environment with guidance being given as it is needed. It is important to choose problems that are interesting, that are real or realistic, that use different types of technology, and that are likely to have some transferability to the in-service teachers' classrooms (perhaps in a simplified form).

We have offered the course once, and have achieved some of the objectives well. Some of the problems used in the course were:

Using Markov Chains to see how market share changes among AT&T, MCI, and US Sprint. We saw how different marketing strategies lead to Markov Chains and different steady state solutions.

Modeling wait times in line at a bank and using probability to decide whether a single waiting line is sufficiently more efficient to prefer it to a waiting line for each teller. Because some people object to being "herded like cattle," it is important to see how much more efficient the single line method is.

Creating a video game on a graphics calculator that shoots at targets placed at integer values. This game could be created with a graphics calculator with or without programming, or with a computer algebra system. A computer spreadsheet was used to determine an array of integers that generated flight paths, shooting locations, and hit targets, all of which were integers. Thus a sequence of different flight paths, shooting locations, and hit targets could be generated.

Using matrix operations to find the true tax rates for Alabama citizens, whose state tax is deductible from the federal tax and whose federal tax is deductible from the state tax.

Modeling the formula for the pressure on an eardrum from decibel readings obtained in a factory, to evaluate the usefulness of installing air exhaust mufflers.

Finding the effect of inflation on projecting how long investments will have to be made by a company to accrue a 20% down payment for construction of a new building. The Web can be used to obtain formulas and investment information to solve this problem, which is an interesting one for future homeowners.

One assignment was sent via email, and one report using the Web was required.

There was no text for the course, so that the Internet would be used as a resource or so that the required formulas would be developed.

Although the course is designed for both undergraduate and graduate students, the students were all graduate students, and were all in-service teachers, either in high school or at the university level. It turned out that most of the students had some experience with one of the technologies used. For example, one student had experience with matrix operations on a graphics calculator, one had experience with use of email (but not the World Wide Web), one had experience with computer algebra systems, and so on. Even though their knowledge was limited, they were able to lead other students through the discovery of techniques that could be used to solve the given problems. Some students with limited knowledge of technology were more proficient with mathematics content, such as calculus, so their help was also valuable. Thus different students were able to

draw on their experiences to assist in the solution of the problems. Thus each student became a leader for some or all of at least one problem.

We plan to offer the course to undergraduate majors during the Spring 1996 Quarter, so that they will be prepared to use technology when they enter a school system. Our goal is to train some teachers from each of the schools in our service area, so that they can train others and/or encourage them to learn more about the available technology.

Many of the in-service teachers in the state of Georgia do not have easy access to Georgia Southern or any other University that can provide training in the use of technology. Thus we plan to offer this course and others via the GSAMS Distance Learning Network. Making this course available via the GSAMS Distance Learning Network would be expensive, so we plan to seek a grant to defer some of that expense. We have received a grant from the Distance Learning and Telemedicine Board to use Distance Learning to train in-service teachers in the effective use of graphics calculators. We were pleased with the results of the course that resulted from the grant, and the in-service teachers taking the course at several different sites felt that the course and the method of delivery were effective.

We have applied for a \$500,000 matching grant to use distance learning to train in-service teachers to use the World Wide Web. A large part of the grant money is earmarked to supply local school districts with the equipment to receive information via Distance Learning. This grant will provide equipment and training for the use of the GSAMS Distance Learning Network to train faculty in K - 12 schools in the use of the information infrastructure. If this grant is successful, remote sites in the state of Georgia will have the equipment for teachers to take any number of courses.

Even if we are not successful with this grant application, we intend to use Distance Learning as frequently as possible to help teachers teach their students, by offering courses and workshops via this technology. Even though this can be expensive, reaching teachers at distant schools will be well worth the expense.

We are in the process of creating additional courses that teach the use of technology, and to make them part of our degree programs. Some of these courses will be part of a new option for an Ed.D. Degree in Curriculum, the Math/Science/Technology Option. These courses will also be part of several Master's Degree programs and in Educational Specialist programs.

We are confident that using a twin approach of offering both graduate and pre-service undergraduate courses in the use of technology will improve mathematics education in Southeast Georgia. It will introduce the desired skills in the secondary schools at the leadership level and at the novice teacher level, and will encourage other faculty members to gain access to the benefits of technology in their teaching. By offering these courses, we hope to give current and future leaders an in depth training in the use of technology, so that they will be prepared to assist other faculty members gain these skills as we move into the 21st Century.

