

THREE COURSES DESIGNED TO PREPARE SECONDARY MATHEMATICS TEACHERS TO USE TECHNOLOGY IN THE CLASSROOM

Dr. Tim Flood
Pittsburg State University
Department of Mathematics
1701 S Broadway
Pittsburg, KS 66762
tflood@pittstate.edu

Abstract

Several years ago Pittsburg State University began offering three 1-hour courses that are required for teachers seeking secondary or middle school mathematics certification. One course is on the use of manipulatives including Geoboards, Algebra Tiles, Algeblocks, and Miras and is geared to middle school and early high school topics. The second course covers topics on graphing calculators appropriate for middle school and high school. This course provides hands-on experience using the TI-73 and TI-CBL units. The third course is on the use of computer software including Excel, Geometer's Sketchpad, and Maple in the middle school and high school curriculum.

Background

In 1991, the National Council of Teachers of Mathematics published the *Professional Standards for Teaching Mathematics* to provide standards to prepare mathematics teachers who were equipped to implement the NCTM's 1989 *Curriculum and Evaluation Standards for School Mathematics*. The 1991 document caused those in teacher education programs and accrediting bodies to reevaluate the mathematics education curriculum. In particular, the 1991 document included:

TEACHING: Standard 4 - Tools for Enhancing Discourse

The teacher of mathematics, in order to enhance discourse, should encourage and accept the use of-

- computers, calculators, and other technology,
- concrete materials used as models;
- pictures, diagrams, tables, and graphs;
- invented and conventional terms and symbols;
- metaphors, analogies, and stories;
- written hypotheses, explanations, and arguments;
- oral presentations and dramatizations.

The department faculty members considered various ways to ensure the curriculum met this standard, particularly as it relates to the use of technology. At the time, instructors in several of the math content courses used various forms of technology in the classroom. However, it was soon determined that a “techniques” course was needed to allow the prospective teachers adequate exposure to the various uses of technology in the classroom. By creating this as a separate course, it allowed the department to have better control of the process and ensure all students received similar instruction.

Over the next few years, the department faculty worked to design the course. It was determined to offer the content in three 1-hour courses that fit together in one time slot like a regular 3-hour course. Each course runs for five weeks of the 15-week semester. The courses are Manipulatives for Teaching Mathematics, Calculators in Teaching Mathematics, and Mathematical Software. There were several reasons that caused the department to favor offering this as three separate courses, rather than one course that covered all of these. These reasons included:

1. No faculty member in the department had expertise in all areas of technology use. Three faculty members were identified that collectively had the required expertise. The three-course format made it easier to handle issues related to faculty load.
2. At the time, the courses were not required for middle school teachers. However, the Manipulative and Calculator courses were highly recommended for these students. The Software course was seen as less valuable. Now, all three courses are required for both middle school and high school math teachers.
3. By offering it as three separate classes, math majors who were not education majors could take, as electives, the portion most beneficial to them.
4. The 1-hour format is conducive to offering the courses independently as short-courses for in-service teachers.

After the initial development of these courses, they have been under constant revision to keep up with changes in available technology and recommended standards. The most recent standards were the 2003 *NCATE/NCTM Mathematics Program Standards*.

Manipulatives for Teaching Mathematics

This course was developed by Dr. Hazel Coltharp and although it may not be viewed as “technology,” it certainly would be included in “tools for enhancing discourse.” This may well be the most important course for our students. Our students have had experience with graphing calculators and computer algebra systems in the college courses they have taken. However, many are unaware of the uses of manipulatives in the classroom. This course demonstrates the use of Tangrams, Geoboards, MIRAs, Hands-On Equations, Algebra Tiles, and ALGEBLOCKS.

The department has individual sets of each of the manipulative that are loaned to students for the duration of the course. The students work in groups of 3-5 (grouped by grade level) and also give individual presentations demonstrating the use of the various manipulatives. The students review articles related to the use of manipulatives in the mathematics classroom and complete an internet project associated with the use of manipulatives.

Calculators in Teaching Mathematics

This course was developed by the author to provide experiences with graphing calculators that the students may not have been exposed to in a traditional Calculus course. As such, the graphing features of the calculator are deemphasized and some of the other capabilities such as data analysis, programming, and data collection are emphasized.

Although nearly any graphing calculator would be adequate for this course, various Texas Instruments calculators have been used. This is mostly due to the availability of calculators in the department and the support TI provides for education. The course was originally developed with students using a TI-83 and in more recent years has utilized a TI-73 in lieu of the TI-83. It is the philosophy of the instructor to use a calculator with fewer features rather than a more powerful model. The students from this course matriculate to a variety of school systems with tremendous variation in the availability of technology. The techniques learned on the simpler calculators are more forward compatible with the more advanced calculators than they would be from the more advanced to the simpler. A portion of the course is devoted to the advanced features of the more powerful calculators such as the computer algebra and dynamic geometry capabilities.

The course is divided into three main components: data analysis, programming, and data collection. Throughout all of these components, data transfer between calculators using link cables and computer connectivity via the graph-link is emphasized. In the data analysis component, students gain experience entering and editing data, creating statistical plots, and curve fitting. These skills are valuable in and of themselves and are also necessary later in the course for the data collection component.

As a prerequisite, students are required to take a computer programming course. They have several options of computer language, but all students in the course should have some experience writing computer code. The calculator programming expectations are somewhat minimal due to time constraints of the course but are designed to demonstrate the capabilities of the calculator. Several programs are developed with the class as a whole and the students are asked to individually create two programs. The first is to produce a program that will output the quotient and remainder given an integer dividend and a positive integer divisor without using the integer division capabilities of the

calculator. The second program builds on the first and requires the students to write a program that implements Euclid's Algorithm to find the greatest common divisor of two integers. Even though these programs are simple (less than 10 lines each) and the students have prior computer programming experience, this component causes the most difficulty for the students.

The last component of the class involves data collection and builds on the other two components. The use of the TI-CBL is demonstrated in class and several experiments from the *CBL System Experiment Workbook* are demonstrated. In the course of these experiments, the prior data analysis techniques are used and the structure of the programs required for the experiments are examined. The students are placed in groups of 4-5 and asked to select and present to the class one of the other experiments from the workbook.

The assessment of student learning is very difficult and time consuming for this course. Students submit various assignments via the graph-link and their work is evaluated. Other avenues of submission would be possible but do not seem to work well in the short time-frame of the course.

Mathematical Software

This course was developed by Dr. Elwyn Davis and utilizes Microsoft Excel, Geometer's Sketchpad, and Maple. Excel is included due to its functionality and universal availability. Topics covered include: solving mixture problems by trial and error, creating amortization tables and examining the effects of changes in term or interest rate, performing matrix operations, and techniques for graphing $f(x)$ and $f(x, y)$.

Geometer's Sketchpad is popular in high school classrooms and useful in middle school instruction as well. Standard high school constructions are explored along with testing of conjectures and the demonstration of theorems such as the median concurrency theorem. Linear transformations are investigated including demonstrating translations and rotations as products of reflections. The process of embedding digital photos is demonstrated and the students select points on a photo of a roofline or stream of water from a fountain and find the regression curve either using Excel or a graphing calculator.

Maple is included to give the students experience with a computer algebra system. The principles and capabilities of symbolic algebra system are emphasized instead of specific Maple commands. In addition to the algebraic manipulation the software is capable of performing, the graphing capabilities are compared and contrasted with those of the graphing calculator. Maple is also used for exact curve fitting by solving the associated system of equations. Although this computer algebra system component is beneficial, it may be replaced in the future by some other computer technology used more in the secondary classrooms such as interactive white boards.

Conclusion

There are many additional topics that could, and maybe should, be included in each of these courses. However, it is a very careful balancing act of trying to select the most appropriate topics that will fit into the 5-week course. One could argue that each course should be extended to include more topics, but there is simply not room in the program for additional hours. In spite of these shortcomings, these courses are helping to prepare students to use technology in the classroom. Since the inception of these courses, the department has received an array of positive feedback. Students are much more likely to use technology in mock teaching exercises in their subsequent Techniques for Teaching Mathematics course. The response from cooperating teachers has been very positive. They indicate our students are well prepared in this area and often provide assistance to the cooperating teacher on the use of technology in the classroom. After in-service teachers have taken one or more of these courses during summer workshops, they indicate a higher level of comfort with the use of technology and often incorporate it more into their delivery of information.

It is crucial that the instructors of these courses, and the department as a whole, stay current on the trends in technology. As technology evolves, so must these courses. Some changes have already been made over the ten-plus years these courses have been offered. Looking into the near future these courses will need to include segments on interactive white boards and other emerging technologies. Beyond a few years, it is anyone's guess as to what the future may hold.

References

National Council of Teachers of Mathematics. *Curriculum and Evaluation Standards for School Mathematics*. Reston, Va.: National Council of Teachers of Mathematics, 1989.

———. *NCATE/NCTM Mathematics Program Standards*. Reston, Va.: National Council of Teachers of Mathematics, 2003.

———. *Professional Standards for Teaching Mathematics*. Reston, Va.: National Council of Teachers of Mathematics, 1991.

Texas Instruments. *CBL System Experiment Workbook*. Austin, Tx.: Texas Instruments, Inc., 1997.