COMPUTING FOR SECONDARY EDUCATION MATHEMATICS MAJORS

Drs. Lisa A. Lister and Yixun Shi
Bloomsburg University
Department of Mathematics, Computer Science and Statistics
Bloomsburg, PA 17815
llister@bloomu.edu, yshi@husky.bloomu.edu

According to the Standards published by the National Council of Teachers, technology is an essential part to the teaching and learning of mathematics. At Bloomsburg University we offer a course for Secondary Eductation Mathematics majors that introduces them to the use of accessible technology in the classroom. In this paper we will discuss the history of the course and briefly describe its content.

History and Objectives of the Course

This course was originally offered about 20 years ago. In the beginning, the course relied primarily on Appleworks to teach spreadsheets and word processing as well as Basic for programming and graphics. Over the years, as technology has changed this course has evolved as well.

The course is now our department's response to a required computer course offered to all Secondary Education majors. Since the needs of mathematics teachers are very different in terms of the technology they will be expected to know, we feel that developing a course geared specifically to them was essential in preparing our students for their futures. The programming aspect of the course has been replaced with the introduction to a variety of mathematical software packages and calculators. Our objectives are that students learn the effective use of technology; be aware of the trends throughout the country in the use of technology; and know how technology can enhance the teaching and learning of mathematics as well as change the way in which mathematics is taught. To achieve these goals, we begin by introducing students to the NCTM and the four principle ways in which technology can be used, namely demonstration, computation/application, learning tool, and discovery.

Use of Technology

Demonstration: Using technology, as a demonstration tool is one of the more common ways we are used to seeing technology. It allows us to draw graphs or to demonstrate theorems or definitions. For example, there are packages that will create conic sections using the definition, allowing students to see how conics are really created; or a teacher can use a glass of ice water and a CBL to demonstrate Newton's Law of Cooling. These are just two examples, but we have all seen many others.

Computation/Application: For years, technology has been used as a computation tool. From grade school on we are used to using our calculators to evaluate expressions like $\sqrt{26}$. Over the years however technology has improved allowing us to do much more.

With the introduction of computer software packages and calculators like the TI-89, we can now, in the classroom, solve complex equations, factor sixth degree polynomials over the reals, etc. The growth and improvement of technology has given and will continue to give teachers more freedom in their classes to explore more real world applications, where "messy" computations involved. For example, calculators can now take real data sets and produce equations modeling that data; equations no longer restricted to linear or quadratic, but instead exponential, sine, or logistic curves are also possibilities. These applications allow students to see how math is used in the real world and allow teachers to begin to answer the age-old question: "Where will I ever use this?"

Learning Tools: Software companies are learning, with the use of technology and the popularity of computer games, that computers can be used to learn mathematics, if presented in a way to keep student interest. Companies such as Sunburst have a variety of products, for all levels, that teach mathematical concepts in a gaming format. Green Globs is an excellent game that teaches students about properties of polynomials. The players want to create a function that hits as many of the globs as they can, achieving a higher score for the more they hit. There is the Hidden Temple of Aljabar, a game in which the player's goal is to find the hidden treasure. To achieve this goal, they must translate sentences into mathematical equations, solve inequalities, and even solve basic systems of equations. This is a fun game for first or second year algebra students.

Discovery: The hardest and often most useful way in which technology can be used today is in the discovery of different theorems or equations. An example, is having students discover the relationship between sides of a 30°-60°-90° triangle or the relationship between opposite interior angles. These labs however, are often the hardest use of technology for both students and teachers. For students, discovery activities are often the first time they have to formulate their own conjecture. They feel more comfortable being told what the outcome is and don't like the uncertainty involved in the discovery exercises. For teachers it takes practice to direct students without giving them the answer. Having lots of questions prepared to answer student questions with is a must. Teachers often see the students' frustration and want to help by giving too much information defeating the purpose of the exercise. But just remember, the advantage of discovery labs, is that what you learn or discover for yourself, you learn better and remember longer.

Software and Technology Introduced

Creating Web Pages: For this portion of the course, we first discuss the concepts of web site, web site address, web pages, and so on. After that, we go through basic syntax and programming skills with HTML. This helps students to understand the difference between "pages" and "source codes", and also prepare them for the cases when they need

to make changes through the source codes. We then show students how to use MS Word to prepare web pages. The reasons that we choose MS Word to do this are: (1) this software is available on almost every computer; (2) the course materials prepared by our students (future teachers) are most likely to be prepared with a word processor such as MS Word, and hence it is natural to just convert the document into web pages.

Currently in this course we concentrate on posting course materials as web pages. In the future, we may also consider talking about preparation of online courses.

Student project for this portion is to write a set of web pages to post the materials that the student would teach at his or her first class presentation. For example, they may use one page for "Introduction", one for "methods/formulas", one for "exercises", and one for "homework". They will make links between these pages so that viewers can easily move back and forth. Links will also be made to Internet web sites that can be used as references or teaching resources.

MS Word: Most of the students in this class already know how to use this software to prepare documents. Therefore we skip the basic skills part. We concentrate instead on using the Equation Editor for mathematical notation and equations. Students are very fast in learning this part. As applications, we have students do the following exercises:

- Develop course syllabus.
- Prepare quizzes and tests.
- Prepare class handouts such as lecture notes, examples, class exercises, etc.

MS PowerPoint: For this software we start with basic skills and show students all the steps needed to prepare a presentation. We talk about some general approaches that people follow when using PowerPoint to prepare lectures. This includes organization of slides, choice and consistency of color, selection of background to avoid distraction, and so on. How to insert mathematical equations and notation is also discussed.

Students are required to make two presentations using PowerPoint to teach mathematics. One presentation is combined with the application of Excel to teach a subject of algebra, and the other with MATHEMATICA to teach a subject of calculus. Student presentations are evaluated by both instructor as well as the rest of the class.

MS Access: In this course we also introduce the applications of database management software such as MS Access in general school administrations. Students are required to create a mini database showing students' course schedules, which has three tables: **Students, Courses,** and **Schedules.** They are also required to set up appropriate relationships between the tables so that queries and reports can be run.

MS Excel: Most of students know how to use this software, but many of them are not familiar with formula copying and mathematics functions. So in the class we concentrate on the use of functions, copying of formulas, making graphs, and applications in teaching mathematics. The applications we discuss include the following:

(a) Application in teaching algebra
- Make function value tables.
- Sketch function graphs.
- Show the relation between the value of slope and the direction of a straight line.
- For a quadratic function $f(x) = ax^2 + bx + c$, show the relation between the value of a and the shape of the corresponding parabola.
- Perform numerical computation involved in problem solving.

(b) Application in teaching statistics
- Statistical functions;
- Descriptive statistical methods;
- Charts.

Students are required to make a presentation, using Excel (together with PowerPoint as mentioned earlier) to teach a subject of algebra.

MATHEMATICA: Very few students in the class have used MATHEMATICA, hence we start from the very basic syntax and statements. After that we discuss the applications of this software in teaching mathematics, including

(a) Applications in teaching algebra
- Make function value tables.
- Sketch function graphs.
- Show the relation between the value of slope and the direction of a straight line.
- For a quadratic function $f(x) = ax^2 + bx + c$, show the relation between the value of a and the shape of the corresponding parabola.
- Operations on polynomials, rational expressions, and radical expressions – additions, subtraction, multiplication, factorization, simplification, etc.
- Solutions of equations.
- Numerical computation involved in problem solving.

(b) Applications in teaching pre-calculus and calculus
- Graph of functions
- Limits and continuity of functions
- Derivatives and anti-derivatives
- Maximum, minimum, and inflection points
- Summation and integration

Again, each student is required to make a presentation teaching a subject of calculus using MATHEMATICA (together with PowerPoint as mentioned earlier).

Geometer's Sketchpad: Geometer's Sketchpad is a widely used software package at the high school level. One of the main reasons this is true is that this is a package with a lot of versatility that is easily learned by the students. For many of our students this is the first time they have seen Sketchpad and after doing the simple Kaleidoscope lab that comes with the package they feel comfortable with the software. This lab explains how

to do the basics such as creating line segments and circles, to more advanced topics such as animation. After this lab, students practice with the software by doing labs that they could easily adapt to their own classes, labs on topics such as exploring slopes of line and properties of triangle. We show the students how to graph functions, measure objects, explore rates of change, and create scripts that can be used for a variety of labs. For this portion of the class, students must give a 20 minute lesson using Sketchpad to teach a topic of Geometry.

Sunburst Products: As we all know, in general, once we get out into the classroom, no one tells us how to use technology. This is something we must learn for ourselves. To prepare our students for this leap into the unknown, we have the students work in groups with one of the Sunburst Products such as Green Globs or Hotdog Stand the Works. These packages are just a couple of the learning tools published by Sunburst. We choose these packages because of price and reputation. Students are given the software and a manual. Part of their lesson is to learn how to use this software effectively. They then must give a 20 minute lesson using the software, teaching a topic appropriate for their package.

Calculators: We introduce two calculators in this class, the TI-89 and the TI-83. Our students are already familiar with the TI-89 since we require this calculator throughout our Calculus sequence. The students have seen many applications using this product such as area under the curve, maximum/minimum, rates of change, etc. We spend most of our time covering the statistical capabilities of the calculator, an application most of our students have not seen. We then have them use real world data to predict future trend using regression curves.

After using the TI-89, we introduce the TI-83. This calculator is unfamiliar to most of our students even though it is one of the most widely used calculators in high schools today. Students are shown how to enter and evaluate expressions, graphing, statistics, factoring polynomials, etc.

Conclusion

After going to local high schools we have discovered that current teachers are interested in learning accessible technology for their own classrooms. This is one reason why we feel this course is such an important class for our students. As technology changes and evolves, expectations on teachers to use and teach technology will increase and it is our hope that this course will help prepare the Secondary Math Education majors for the challenges of the future.