TECHNOLOGY IN A MASTER'S DEGREE PROGRAM FOR MIDDLE GRADES MATH TEACHERS

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Introduction

Beginning in 2003, John Carroll University initiated a Master of Arts program in mathematics for middle grades mathematics teachers, as part of a National Science Foundation Mathematics and Science Partnership (MSP) Program grant. The need for upgrading the knowledge base of middle grades teachers became apparent when, in 1998, the State of Ohio revised its standards for professional licensure of teachers. Under these new state standards, implemented in 2002, newly licensed teachers of middle grades mathematics are now expected to be specialists in mathematics, rather than "generalists," as had been the standard in the past. As a result, many middle grades teachers, who had previously been certified under the former requirements, suddenly became far less knowledgeable about mathematics than their junior colleagues who were becoming licensed under the new standards. The Master of Arts program at John Carroll University was designed to address this issue by improving the mathematical knowledge of those who are presently teaching mathematics in middle grades.

In this paper we will give a brief overview of the master's program, and then describe, in greater detail, the content of one of the courses, which deals with use of technology in teaching middle grades mathematics.

The Program

The master's program is designed around both the Ohio *Academic Content Standards* [8] and the NCTM's *Principles and Standards for School Mathematics* [7]. Although *process* is an important part of the program, the greater emphasis is on *content*, since the program is founded on the belief that teachers' mathematical knowledge is the foundation on which effective classroom instruction is built.

Teachers are admitted to the program in cohorts, and are expected to take all of the courses in sequence, with their cohort. The program includes eleven courses, all with a primary focus on mathematics, culminating with a capstone course designed around individual "action research projects," which are undertaken by the teachers in the second

and final year of the program. The courses, listed in the order in which they are taken, are:

	Course	*When offered*
MT 520	Mathematics: Process and Content	Fall, first year
MT 521	Number Analysis	Spring, first year
MT 522	Concepts in Algebra	Summer, first year
MT 523	Discrete Mathematics and Linear Algebra	Summer, first year
MT 524	Geometry and Spatial Sense	Summer, first year
MT 525	Mathematics Teaching Technology	Summer, first year
MT 526	Responsive Mathematics Instruction	Fall, second year
MT 527	Probability and Statistics	Spring, second year
MT 528	Topics in Measurement	Summer, second year
MT 529	Reasoning and Communication in Mathematics	Summer, second year
MT 530	Capstone Course	Summer, second year

The Technology Course

The technology course, MT 525, is a blend of lectures, hands-on activites, computer lab work, and student presentations. Topics covered in the course are:

- calculator use (both TI-84 and TI-73), including "Apps" and programming
- interfacing the calculator with the computer
- Geometer's Sketchpad
- using the TI Calculator Based Ranger for data collection and analysis
- technical writing with MathType
- use of Excel in teaching and in record-keeping
- data analysis via computer
- online mathematics resources
- web page authoring

In the remainder of this paper we will describe some of the details of these topics.

Calculators

The course begins with calculator use, because the teachers are already somewhat familiar with this technology. As a part of the MSP grant, each teacher in the program receives a TI-84 calculator and ViewScreen panel—but they typically have only scratched the surface of the calculator's capability prior to taking this course, and most of them have not attempted to use the calculator in their own classrooms. Although two of the texts required for the course, [5] and [6], are activity books for the TI-73, the teachers quickly learn that much of the material can easily be adapted for the TI-84. Using the TI-84 as a case study, the course includes a discussion of screen resolution and its effect on

graphs, and an introduction to programming a calculator. In particular, the students learn to write an "Owner" program that will display the owner's name and phone number, and a quadratic formula program for solving quadratic equations. They also study the inner workings of a program to factor a positive integer as a product of primes.

After building the teachers' familiarity with the TI-84, the course moves on to the TI-73 Explorer, a calculator that is, in many respects, more appropriate for them to use in their classrooms. Since the teachers typically do not own a TI-73, a workshop loan from Texas Instruments is used to provide the calculators for this segment of the course. In addition to the TI-73's keyboard support for arithmetic with fractions, there are several Apps available for the TI-73 that are not available for the TI-84: "Number Line," "Geoboard," and "Building Perspectives."

The Number Line App, illustrated in Figure 1 and Figure 2, supports numerous activities designed to help children visualize number relations among integers, fractions and decimals, as well as addition and subtraction of integers. The book *Walking the Line: Activities for the TI-73 Number Line* [2] has a number of suggestions for creative ways to use this App.

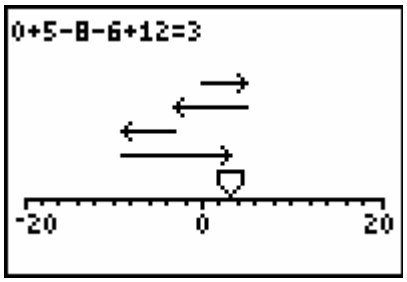

Figure 1: Number Line App

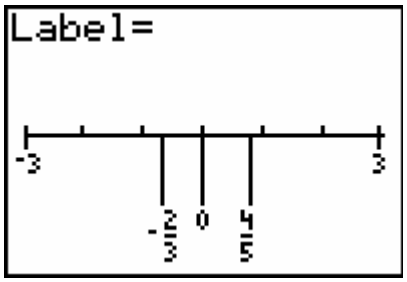

Figure 2: Number Line App

The Geoboard App, pictured in Figure 3, is a calculator version of the traditional Geoboard, and supports boards of various sizes up to 11×11. In addition to avoiding the problem of rubber bands flying across the classroom, it permits measurement of length, area, perimeter and angle, making it possible to structure student discovery of various geometric formulas. Texas Instruments publishes a book [4] with a variety of activities based on the Geoboard App. The Building Perspective App, another App available only

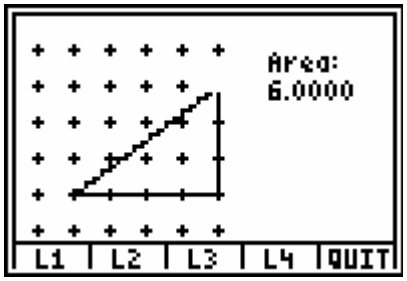

Figure 3: Geoboard App

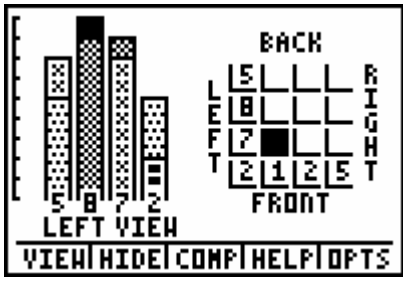

Figure 4: Building Perspective App

for the TI-73, helps students to develop spatial perception and reasoning skills as they try to determine the heights of "buildings" in a "city," given only the views from the four sides. This is illustrated in Figure 4. Among the various Apps available on the TI-73, the hands-down favorite among the middle grades teachers is the Number Line App, for its potential to be useful in the classroom.

Calculator Based Ranger

The Calculator Based Ranger (CBR) from Texas Instruments is a hand-held device that functions like a combination of a motion detector and a CBL. Connecting to a TI calculator, the CBR can record and transmit distance measurements to the calculator, where the data can be displayed in a distance vs. time graph, or analyzed and plotted statistically in, for instance, a boxplot. Another book from Texas Instruments [3] contains a collection of twelve middle grades activities based on the CBR. Another workshop loan from Texas Instruments make CBR's available to the teachers in the technology class.

Technical Writing and MathType

Early in the course, the teachers learn to use MathType for the mathematical symbols in Microsoft Word documents. Along with this skill, they also learn to use the TI Connect software to incorporate calculator screen shots in their documents, as well as to back up their calculators on a computer and offload programs to free up calculator memory space.

Geometer's Sketchpad

Since the technology course is offered concurrently with the Geometry and Spatial Sense course, it is natural to devote a component of the technology course to dynamic geometry software. Several activities from the book *Geometry Activities for Middle School Students with The Geometer's Sketchpad* [9] are the focus of this component of the course. These activities, which are designed specifically for middle grades students, typically emphasize either the learning of geometric terminology, or utilize animations based on geometric figures, because of the special appeal to children of middle school age. Figure 5 shows a Sketchpad screen for a typical simple discovery activity involving pairs of supplementary angles.

Excel

Although most of the teachers indicate that they have experience with Excel, that experience seems to be quite limited. For example, in the summer of 2005, all of the teachers were extremely glad to learn how to build a simple grade book spreadsheet. In addition to this somewhat mundane application, other spreadsheet activities include generating the Fibonacci numbers and observing their ratios approaching the golden

ratio; creating "graph paper" with a spreadsheet with empty cells; and creating dot paper by centering a dot symbol in each cell.

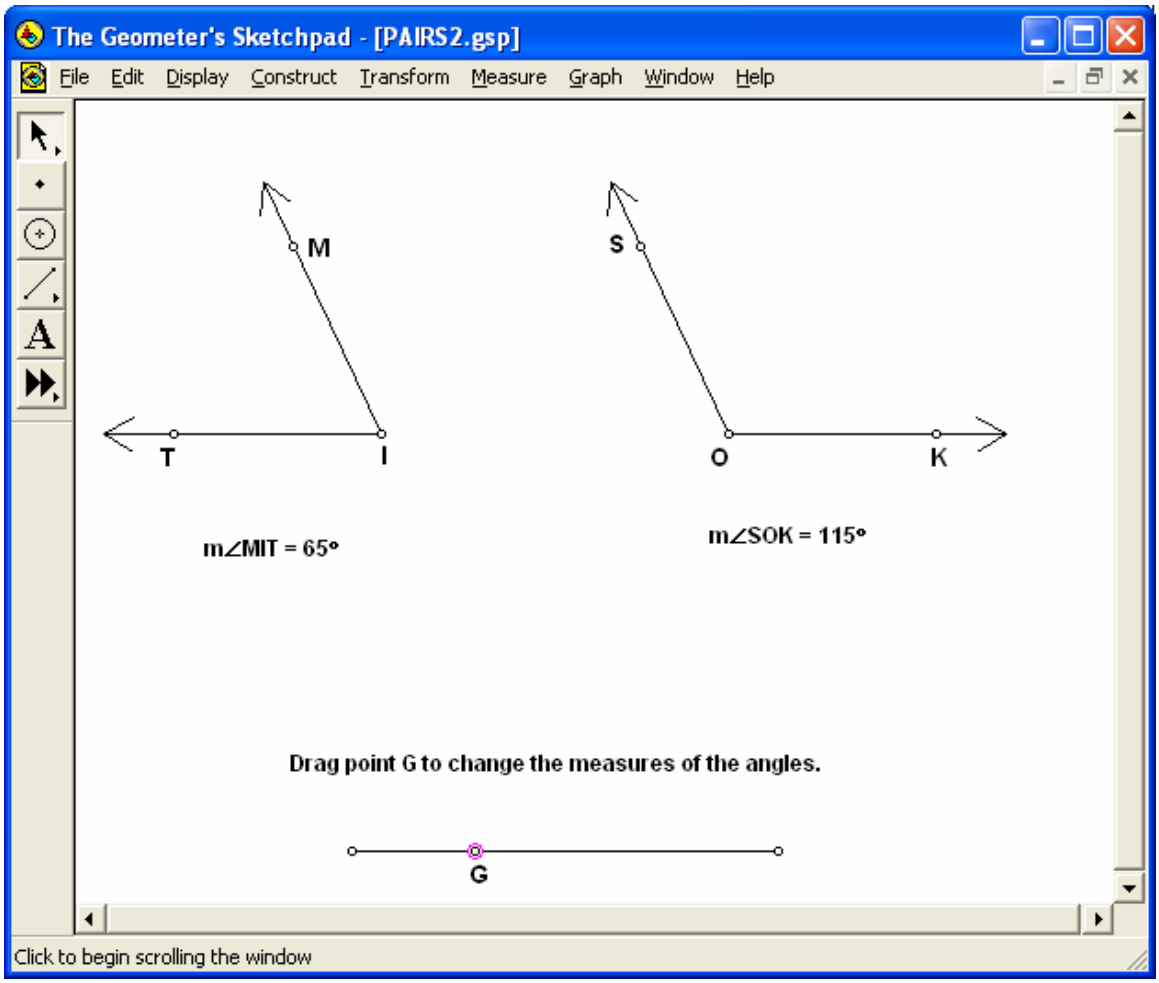

Figure 5: A Sketchpad Activity for Middle Grades

Data Analysis

For the data analysis component of the course, we use the book *Navigating through Data Analysis in Grades 6—8* [1] as a source of NCTM Standards-related activities. This book comes with a CD containing not only the text of the activities and the data, but also a wonderful collection of easy-to-use interactive Java applets, termed "Minitools," which make statistical concepts come to life. (See Figure 6.)

Web Authoring

By popular demand, the technology course includes a component in which the teachers learn to write simple static web pages and publish them on a web server. Using both

HTML and Microsoft FrontPage, the teachers learn to create a professional home page with links to secondary web pages that they create, containing such information as classroom policies, suggestions for parents, lists of online resources, and so on. Although this was not originally planned as a component of the course, we were surprised that the teachers show a great interest in learning how to create a web presence.

Figure 6: One of the NCTM Minitools

Online Resources

One of the most exciting components of the course, for most teachers, is exploration of the wealth of online resources for mathematics teachers. Although several resource web sites are discussed, the real treasure-trove is the National Library of Virtual Manipulatives at Utah State University, which has collected and catalogued dozens of Java applets according to curriculum strand (Number & Operations, Algebra, Geometry, Measurement, and Data Analysis & Probability) and grade level. Many of these applets are superb teaching tools. One of the applets, visualizing addition and subtraction using base blocks, is shown in Figure 7. The entire library of applets may be purchased on CD at a moderate cost, for use in classrooms without internet access. They are also available online, at http://nlvm.usu.edu/en/nav/vlibrary.html .

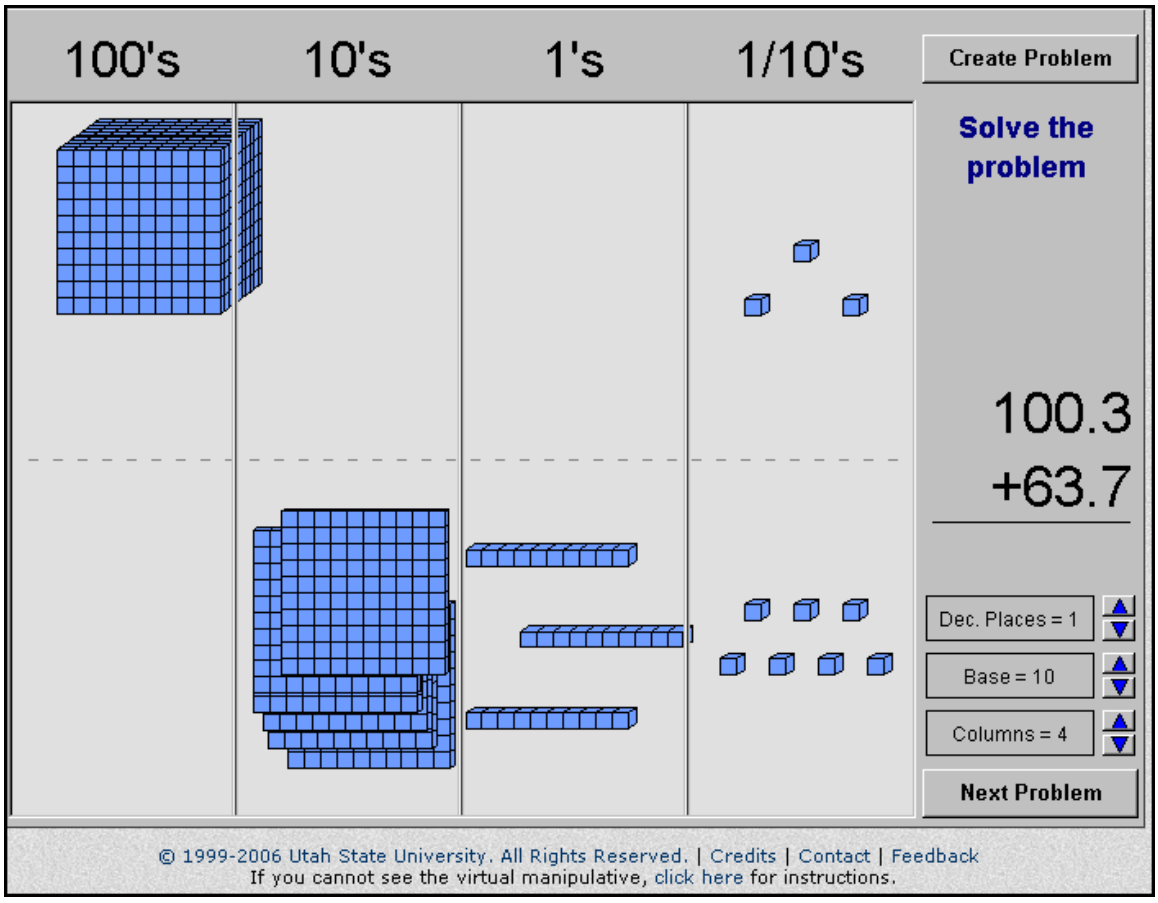

Figure 7: A Virtual Manipulative—Addition using Base Blocks

Conclusion

While the upgrade of the state's licensure standards for middle grades mathematics teachers is laudable, it has placed many current teachers squarely on the path to obsolescence. The Master of Arts program in mathematics for middle grades teachers at John Carroll University is helping to fill the resulting need for professional development among teachers in our area, and the technology component of that program is one way in which the teachers are encouraged to seek out innovative and effective ways to help children learn mathematics. Each of the courses in the program involves a substantial time commitment on the part of the instructor, as the teachers enter the program with very minimal mathematics background but with a great desire to learn. Our hope is that the investment in time and energy will pay long-term dividends in the form of improved mathematics education for middle grades children at this critical time in their schooling.

References

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