INTEGRATING TECHNOLOGY/ENGINEERING CONCEPTS INTO THE TEACHING OF MATHEMATICS IN MIDDLE SCHOOL

Mary Ann Connors
Department of Mathematics
Westfield State College
Westfield, MA 01086
mconnors@wsc.ma.edu

A five day summer professional development institute to enable 5th -8th grade teachers to deepen their knowledge of mathematics and engineering/technology concepts and develop hands-on classroom activities with respect to the Massachusetts Curriculum Frameworks was held August 15-19, 2005, 8:30am-4:30pm at Westfield State College. The instructors were a high school engineering technology teacher and a college mathematics professor. The area of focus for this course included mathematics content generated by hands-on activities on engineering design, building bridges, and other relevant topics. The activities included concepts, required materials, introduction, Massachusetts Mathematics Standards addressed, activity sheets, and teacher notes.

The content and pedagogy course was sponsored by PV STEMNET - a network of schools, institutions of higher education, other formal and informal educational organizations, and industry. It was established with funding from the Massachusetts Board of Higher Education. The purpose of the Pipeline Fund is

- "to increase the number of Massachusetts students who participate in programs that support careers in fields related to mathematics, science, technology, and engineering...
- to increase the number of qualified mathematics, technology, engineering and science teachers in the Commonwealth and
- to improve the mathematics, technology, engineering and science educational offerings available in public and private schools."

The Grant provided funding for 20 participants. Each received a $450 Stipend, a TI-84+ SE hand-held calculator, breakfast, lunch, and snacks. Graduate credit was optional for a fee of $240.

Course Description: This course is designed to enable 4^{th} -8^{th} grade teachers to deepen their knowledge of mathematics and engineering/technology concepts and develop hands-on classroom activities with respect to the Massachusetts Curriculum Frameworks. The areas of focus for this course will include hands-on activities on Engineering Design, Building Bridges, Motion, and other relevant topics. This course also incorporates the standards of the NCTM (National Council of Teachers of Mathematics) and the Massachusetts Curriculum Frameworks. The NCTM strongly supports the position that cooperative learning, the appropriate use of technology, making connections, and hands-on activities should be an integral part of problem solving in any mathematics course.

The focus of the course is on developing activities for problem solving in middle school mathematics courses. Various methods of data collection and analysis are explored. Collecting, organizing, displaying, analyzing and comparing data are included. Some of the activities involve collection of data with the Calculator Based Ranger (CBR) and TI-84 Plus hand-held calculator.

Course Rationale: The goal of the course is to promote student centered learning with problem solving activities including the appropriate use of technology. This course emphasizes individual responsibility for the learning process. The teacher participants will develop activities to use in their own middle school or high school mathematics courses. Group work and completion of classroom curriculum projects are an integral part of the course. The course will serve as a possible model for teaching in the participant's classroom.

Course Requirements: Participants are expected to attend classes, complete all activities, and design a curriculum project. Before the end of the course participants will present their projects and share copies with the other participants. Ideally, the project should be completed with a partner. The project should include an introductory section on the rationale for the lesson plan, the classroom grade level, how the lesson fits with the district's curriculum, an appropriate calculator activity for teaching the material, and an analysis of how the success of the lessons will be determined.

Grading Criteria: Grades are based on attendance, completion of class activities, and presentation of a project (an activity) created or modified by the participant for use in the middle school classroom. Grading will be done by evaluation of class attendance, active participation, completion of activities, and presentation of a classroom curriculum project as specified in the following chart.

Grading Criteria	Percent of Grade
All assignments must be completed before a grade will be submitted.	
Class Attendance: Daily from 8:30 AM to 4:30 PM	20% of grade
Class Participation: Each student will complete activities in class and demonstrate an understanding of required readings by actively contributing to class discussion	20% of grade
Project-Based Activity: Each student will develop an appropriate activity to be used in his/her middle school mathematics class. In order to produce a quality document, effort will be necessary both inside and outside the framework of the classroom. The completed curriculum work will be turned in to the instructor for evaluation. Students may submit a hard copy of the document or a copy on disk.	30% of grade
Presentation: Students will present individually or as a team the results of the curriculum developed. Each student will provide copies of his/her activity to all members of the class.	30% of grade

Course Outcomes: As a result of successful completion of the course, the student will be able to provide mathematical instruction that will:

- Enhance students' problem solving strategies
- Provide an interdisciplinary environment developed from working with teachers from other fields.
- Make use of cooperative learning, collaborative groups, and peer teaching.
- Implement technological support (i.e. TI-84+ SE hand-held calculator)

Course Schedule

Day 1	Building Bridges, Engineering Techniques, Applications, Processes
Day 2	Spaghetti and Bridge Support, M&M's and Containers
Day 3	Bouncing Balls and Parachutes
Day 4	Walking the Line, Gliders, and Catapults
Day 5	Student Presentations and Sharing Activities

The following figures illustrate some of the activities.

Figure 1 Building Bridges

Figure 2 Bridge Support

Figure 3 Bouncing Balls

Figure 4 Building Parachutes

Figure 5 Testing Parachutes

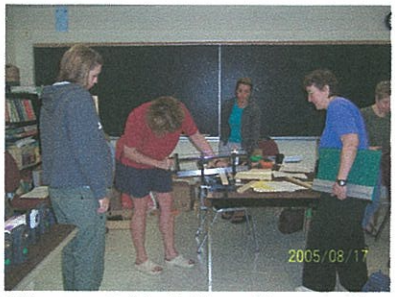

Figure 6 Building Catapaults

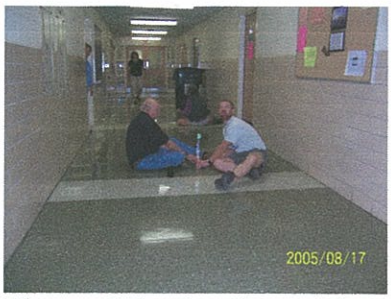

Figure 7 Testing Catapaults

Figure 8 Participant Presentation
House and Roof Design
for Different Climates

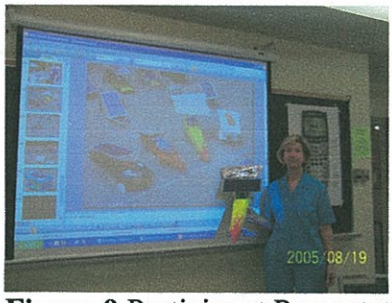

Figure 9 Participant Presentation
Junior Solar Car Sprints

Each activity connected specific mathematics content and mathematical modeling to the appropriate engineering technology application. For example, in the Bouncing Balls activity, a CBR connected to a TI-84 Plus SE calculator is used to collect and store data from a bouncing ball. The data is then analyzed to find the relationship between drop height and bounce height using numerical, graphical, and analytical points of view.

Results:
Participant presentations included the following topics:

- Junior Solar Car Sprints
- Investigation on Friction Between Axles and Bearing of Various Materials
- House and Roof Design for Different Climates

- Collision, Momentum, and Bouncing Balls
- Paper Airplane Activity
- Parachute Jump Competition
- How Many Times Larger is Shaq's Hand Than Yours?
- Fluid Flows and Friction Losses in Pipes
- Building a Garden Fence
- Build a Tower as High and as Strong as You can Using a Limited Supply of Marshmallows and Pasta
- Construction Cranes: How Much Weight Will It Hold?
- What's the Tallest Tower You Can Build Using Only Two Sheets of Newspaper?
- Exploring Constant Area and Changing Perimeter
- Population Data

The teacher participants were enthusiastic about the learning experience and said that they looked forward to incorporating the activities in their teaching. Some participant follow-up comments after returning to their classrooms:

> …I do want to mention that we have been doing some informal engineering projects- the tower activity. We've worked on heights and durability- having to withstand earthquakes (shaking of table) and winds (of varying intensities: tropical depression, tropical storm, and hurricane- fan with 3 speeds). This has tied in nicely with weather unit and with current events.
>
> Wanted to drop you a note saying how much I enjoyed the summer session. The kids are already asking about fun projects to work on and I've told them I picked up some great ideas at your course.
>
> I spoke to you about Science Overnight ... We use staff, experts, and pre-service teachers to run the mini courses (7 sessions). Class size is 8 to 10 students per class. Classes are 45 minutes. Most of our presenters do have a math component to their hands on science.
>
> I just have been busy getting ready for the school year. I was able to find a View Screen in my district that I will be able to borrow, and the assistant superintendent said that she will purchase the CBR2! I can't wait to use them in the class. Thanks for exposing us to all these great ideas we can use in the classroom.
>
> Once again, thank you for a great course. Having observed many creative activities all week, I know I can integrate activities at least once or twice a week into math and science and perhaps other areas, something I've been wanting to do for a long time. I have many more resources to use that will be a big help in accomplishing this. …I met my personal objective, learning how to integrate these areas to provide more effective, interesting and fun activities for my students and to share with my colleagues. Thanks again.