USING TECHNOLOGY AS A VEHICLE TO APPROPRIATELY INTEGRATE MATHEMATICS AND SCIENCE INSTRUCTION FOR THE MIDDLE SCHOOL

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At the College of William and Mary, pre-service middle school science and mathematics teachers enroll in their respective methods courses taught in the same time period. Both instructors emphasize the importance of the content pedagogy unique to their disciplines in their individual courses such as strategies for teaching problem solving, computation, proportional reasoning, algebraic and geometric thinking in mathematics, and strategies for teaching students how to "investigate" or design and conduct experiments in science. However, the two classes come together for sessions in which they examine the relationship of the two disciplines and the proper role of technology, both graphing calculator and computer, in their instruction. Starting with resources such as *Science in Seconds for Kids* by Jean Potter [1], the science students collaborate with the math students to design and conduct brief experiments. The data generated is analyzed using spreadsheets and later graphing calculators. Various classes of mathematical curves are examined using data generated by sensors/probes and CBLs. Through this experience the pre-service teachers learn to work collaboratively with their colleagues on meaningful tasks, strengthening the effectiveness of all participants.

Among the competencies that the new teacher licensure regulations for middle education (6-8) in Virginia prescribe that the teacher candidate demonstrate are:

1) the ability to plan and teach collaboratively to facilitate interdisciplinary learning;
2) the ability to analyze, evaluate, apply, and conduct quantitative and qualitative research;
3) the ability to use technology as a tool for teaching, learning, research, and communication.

In order to accomplish these goals, the mathematics education and science education faculty at the College of William and Mary have redesigned the methods courses for these prospective teachers in both areas. Both instructors, Mason in mathematics education and Giese in science education, emphasize the importance of the content pedagogy unique to their disciplines in their individual courses such as strategies for teaching problem solving,

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proportional reasoning, algebraic and geometric thinking in mathematics, and strategies for teaching students how to "investigate" or design and conduct experiments in science. However, the two classes come together for sessions in which they examine the relationship of the two disciplines and the proper role of technology, both graphing calculator and computer, in their instruction.

In their mathematics methods course, students learn strategies to teach four core processes in mathematics: becoming mathematical problem solvers, reasoning mathematically, communicating mathematically, and making mathematical connections within the discipline and to other disciplines. In their science methods course, students learn strategies for teaching experimental design including the components of an experiment. After analyzing the components of several simple experiments and suggesting ways to improve them, students learn strategies for using different science-related prompts, a general topic, a neat demonstration, an advertisement or a newspaper article, and the Four-Question-Strategy to design an original experiment. These skills are then applied to designing and conducting experiments which integrate math and science concepts utilizing technology. Starting with resources such as *Science in Seconds for Kids* by Jean Potter [1], the students collaborate to design and conduct brief experiments. The data generated is analyzed using spreadsheets and later graphing calculators. Various classes of mathematical curves are examined using data generated by sensors/probes and CBLs. Through this experience the pre-service teachers learn to work collaboratively with their colleagues on meaningful tasks, strengthening the effectiveness of all participants.

For example, one such experiment involves testing an inflated basketball. As described in the book *Sensor Sensibility* [2], a basketball which is inflated properly rebounds to 75% of its original height if it is dropped. In this experiment, students drop a basketball underneath a motion detector. The motion detector will record the distance to the ball for a long enough time to collect values for at least five bounces. The students then analyze the data to see whether the ball passes the 75% rebound test and find a mathematical function to describe a bouncing object.

Students identify the independent variable and the dependent variable in this experiment. They then predict the graph of the data, labeling the axes to indicate the independent and dependent variables. They next guess the type of function that will model any part and justify their choices. Then they perform the experiment using a CBL system, TI-83 graphing calculators, a motion detector, and a basketball. Generally, the students experiment with the measurements they take, varying such things as the time interval and the height from which the ball is dropped. Eventually, once they have settled on a design and collected their data, they analyze it, comparing their graphs to the predicted ones and accounting for the differences. They find a function that fits the graph well and justify that function as a good model. (It is a decaying exponential function.) The numbers in the data table showing the heights of bounces will match a geometric sequence. The ratio between these numbers is more or less constant, and matches the elasticity and inflation of the ball. The height from which students initially drop the ball is the first term in the sequence. If students are familiar with equations of parabolas, they can model a single bounce with a quadratic function.

By working together to design and carry out such experiments, both preservice mathematics and science teachers learn how to collaborate with one another and integrate instruction in these disciplines where appropriate. ■

References

[1] J. Potter, *Science in Seconds for Kids: Over 100 Experiments You Can Do in Ten Minutes or Less,* John Wiley & Sons, Inc., New York, NY, 1995.

[2] J. Randall, *Sensor Sensibility: Algebra Explorations with a CBL™, a TI-82 or TI-83 and sensors,* Key Curriculum Press, Emeryville, CA, 1998.