

# INNOVATIVE OPPORTUNITIES FOR ELEMENTARY AND MIDDLE SCHOOL TEACHERS TO MAINTAIN CURRENCY IN MATHEMATICS AND SCIENCE: A COMMUNITY COLLEGE-SCHOOL SYSTEM PARTNERSHIP

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Since 1992 the Manassas Campus of Northern Virginia Community College – in response to requests from local school systems – has developed four innovative methods of assisting elementary, secondary and middle school teachers to enhance their **content knowledge** in science and mathematics, as well as **integrate** curriculum units for classroom presentation.

These methods are based on the assumptions that:

- While teachers at this level have fundamental understanding of math and science, if they wish to incorporate new concepts or technologies from these fields, graduate level content courses are generally beyond their background level.
- Community College faculty can often provide a bridge that connects advanced content in science and mathematics with the applications that can be adapted to elementary/middle school curriculum.
- Presenting content to a mixed audience of teachers from K-8 allows teachers to see how content can be “adapted” to grade levels above and below.
- Content delivery methods must be interactive and must be responsive to the multiple demands on these teachers’ time. This requires flexibility in scheduling and course requirements.

In the 1991 *Professional Standards for Teaching Mathematics* [1], the National Council of Teachers of Mathematics (NCTM) asserts two fundamental assumptions:

- Teachers are the key to changing the way in which mathematics is taught and learned.
- Teachers must have long-term support and adequate resources.

Under the Standards for the Support and Development of Mathematics Teachers and Teaching, the third standard, relating to the responsibilities of colleges and universities, notes that these institutions must take an active role in supporting mathematics and mathematics education by encouraging faculty to:

- spend time in schools working with teachers and students;
- collaborate with schools and teachers in the design of pre-service and continuing education programs;

- offer appropriate graduate courses and programs for experienced teachers of mathematics.

Although the role of the Community College was not specified in this document, since 1992, Northern Virginia Community College – Manassas Campus has responded to local school systems’ needs by developing four instructional models for implementing these Standards. The focus of the school systems and the community college has been on developing innovative methods for assisting elementary, middle and secondary school teachers who wish to enhance their **content knowledge in science and mathematics**, as well as to **integrate** curriculum units for classroom presentation. In addition to gaining expertise in new content areas and using emerging technologies, faculty members have expanded their own critical thinking skills and have learned to design instructional units that develop critical thinking skills. For both the teachers and their students, planned activities leading to critical thinking in mathematics and science enhances the understanding of these subject areas, reduces the amount of rote memory and helps build those connections which enable *transfer* to occur. Both teachers and students learn the art of reasoning and problem solving.

The instructional models developed by the community college and the school systems are based on the following assumptions:

- While teachers in K-8 have a *fundamental* understanding of mathematics and science, when they wish to incorporate new concepts or technologies, graduate level content courses are generally beyond their background level.
- Community college faculty can often provide a bridge that connects advanced content in science and mathematics with the applications that can be adapted to elementary/middle school curriculum.
- Presenting content along with instructional methodologies to a mixed audience of teachers from K-8 allows teachers to see how content and teaching techniques can be “adapted” to grade levels above and below that which they teach.
- Content delivery methods must be interactive and must be responsive to the multiple demands on these teachers’ time. This requires flexibility in scheduling and course requirements that both lead to understanding of content *and* relate to classroom instruction.

### *DISTANCE EDUCATION*

**Math Connects: Patterns, Function and Algebra** is taught via satellite to teachers across the state and presents an exploration of these strands of the Virginia Standards of Learning to middle school mathematics teachers. Topics are explored through an inductive reasoning approach that leads to a specific mathematical function. Topics include:

- Pattern recognition, functions, and graphing
- Independent and dependent variables, interpretations of graphs
- Probability, expected value, and linear functions
- Ratio and proportion
  1. Slope and equivalent fractions
  2. Slope, steepness, similarity, and the tangent function
  3. Use of proportion in a capture-recapture simulation
- Patterns and exponents
- Patterns with geometry and matrices
- Data collection and analysis
- Perimeter and area functions involving maximum and minimum values on an interval
- Binomials: Pascal's triangle, Zero-product property and algebra tiles
- Sets, logic and combinatorial circuits

Lessons use the Virginia Standards of Learning strand *Patterns, Functions and Algebra* for grades 6-8 and Algebra. Most lessons utilize a graphing calculator and a spreadsheet.

**MTH 150 Topics in Geometry** is available on any VCCS campus by compressed video and was designed to meet the needs of students in the Aviation curriculum and for students working towards initial certification in elementary and secondary mathematics. The course is built around the concept and use of vectors. This gives a dynamic aspect to a normally static course in plane, elliptic and trigonometric geometry, and allows for a myriad of applications that can be used in the field of aviation or taken to the secondary classroom as a practical application of geometry. This course will be a world-wide-web course beginning fall 1999.

### *CONTENT INTEGRATION*

**MTH 295 Special Topics in Mathematics: Integration and Application of Mathematics** has been designed to focus on the integration of mathematical concepts which

are presented in Pre-algebra, Algebra 1, Geometry and Personal Finance courses. Using materials from many sources, teachers develop a resource bank of applications and problems appropriate to all grade levels. These applications show how principles of mathematics are used in many discipline areas and how mathematics itself is an integrated discipline. Through the use of manipulatives, technology, and writing exercises, the following NCTM strands are emphasized:

MATHEMATICS AS PROBLEM SOLVING

MATHEMATICS AS COMMUNICATION

MATHEMATICS AS REASONING

MATHEMATICAL CONNECTIONS

**NAS 295 Special Topics in Natural Science: Integrated Mathematics and Science K-8** has been designed to reinforce concepts and experimental techniques commonly used in mathematics and science, through hands-on experiences. Two 2-credit, sequential courses are offered during the summer in support of the **AIMS (Activities for Integrating Mathematics and Science) Program** [2]. Through critical thinking exercises, teachers learn the mathematics and science concepts that are the foundation for this activities-centered program. Teachers learn to construct activities that relate the two disciplines using the scientific method and critical analysis. Problems are presented to students, the central question for investigation (purpose) is defined, and variables are identified. An experiment is designed, measurements are taken, and the data generated is organized and analyzed. Conclusions are drawn, implications considered, and results are presented.

### *TOPICAL FOCUSES*

While teachers are comfortable with instructional techniques and topics traditionally taught in grades K-8, many are unfamiliar with topical strands that are contained in the NCTM *Curriculum and Evaluation Standards for School Mathematics* [3]. This is particularly true for teachers of the primary grades. For many teachers, the many demands made on their time and their own limited knowledge of mathematics makes taking a math courses a task they wish to avoid. To overcome this problem, a series of courses has been developed for teachers in grades K-6. These courses are taught for one MTH credit each and are offered on two consecutive Friday evening/Saturday combinations. Topics covered include:

- Data Analysis and Probability
- Number Theory and Algorithms
- Transformational and Coordinate Geometry

In these courses, teachers not only investigate mathematical concepts using manipulatives, but they also learn to adapt these concepts to their own grade level. They learn to construct activities that excite and challenge students as well as enhance critical thinking and problem-solving skills. By working in multi-grade level teams, they see how content strands extend from K-6.

### *SOCRATIC TEACHING*

The NCTM *Curriculum and Evaluation Standards for School Mathematics* stress the expansion of topics taught at the elementary level as well as revision of instructional practices. This revision includes the increased attention to **Questioning** and **Justification of Thinking**.

Several schools within the region have implemented the Comprehensive School Mathematics Program (CSMP), published by the Mid-continent Regional Educational Laboratory (McRel) as an alternative to the standard mathematics curricula. This program emphasizes the expansion of basic skills to include higher-order thinking skills. It is a unified study of mathematics, not just arithmetic, and its approach is situational discovery learning presented in a spiral format. Central to CSMP is the methodology of Socratic Teaching. While elementary teachers employ the Socratic Method in their language arts classes, those unsure of their own subject area competency are more comfortable with a do-as-I-show-you approach to mathematics. They need to be convinced that questioning, in addition to showing and telling, enhances in mathematics and science instruction. See, for example, [4], [5], [6].

In preparing teachers for teaching the CSMP program, a unique in-service model has been developed. Groups of teachers are given a 2-3 day introduction to the philosophy, content and methodologies used by CSMP. The teachers review the materials and then, as a group, are freed to observe the trainer delivering model lessons to students at several grade levels. At the end of the day, participating teachers convene to discuss their observations. This cycle is repeated several times before the teachers begin using the materials in the classroom. As the year progresses, the trainer meets with the teachers, the trainer observes classes and the

groups meet to assess the program and plan for further implementation. This monitoring insures that adequate support is provided throughout the year, and other teachers have the opportunity to observe the interactions and adapt these techniques to their own teaching.

### CONCLUSION

By showing these four models we have demonstrated that the community college can provide resources which meet the needs of school systems for in-service education, enhance teachers depth and breadth of content understanding, and facilitate the development of instructional techniques that reinforce critical thinking and understanding. ■

### References

- [1] *Professional Standards for Teaching Mathematics*, National Council of Teachers of Mathematics, Reston, VA, 1991.
- [2] *Activities that Integrate Math and Science, Volume I: Selected Activities for Primary Grades, Volume II: Selected Activities for Middle Grades*, AIMS Education Foundation, 1992.
- [3] *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, Reston, VA, 1989.
- [4] D. A. Grouws (ed), *Handbook of Research on Mathematics Teaching and Learning*, National Council of Teachers of Mathematics, Reston, VA, 1992.
- [5] R. W. Paul, *Critical Thinking: How to Prepare Students for a Rapidly Changing World*, The Foundation for Critical Thinking, Santa Rosa, CA, 1995.
- [6] T. Wood et al, "Rethinking Elementary School Mathematics: Insights and Issues," *Journal for Research in Mathematics Education* (Monograph No. 6) National Council of Teachers of Mathematics, Reston, VA, 1993.