A Description of an Innovative Interdisciplinary Summer Program for Middle School Minority Students

Cathine Garner-Gilchrist
North Carolina Central University

This article summarizes the summer interdisciplinary program in mathematics, science, engineering and technology that was designed to help socially and economically disadvantaged middle school students improve in mathematics and science. The results of the summer program showed that the students' anxiety about mathematics and science was reduced and their interest in mathematics and science increased.

Studies on the state of minorities in mathematics, science and engineering show a small representation (National Research Council (NRC), 1997; National Council of Teachers of Mathematics, (NCTM, 1998); Department of Education (DOE, 1997) and National Aeronautics and Space Administration (NASA, 1997). This small representation of minorities in science and engineering fields may be related to the inadequate preparation of high school minority students in college preparatory mathematics/science courses (NASA, 1997; NCTM, 1997 and NRC, 1996). In fact, NASA (1997) has indicated that Americans who are socially and economically disadvantaged have been significantly under represented in mathematics, science and technology. The report of the Workforce 2000 indicated that a greater number of minorities will be needed to fulfill the labor force requirements in the Year 2000. If the present trend continues, the problem will continue to exist.

However, several organizations have begun to address this need. For example, NASA, NSF, DOE and Engineering Education Coalition (EEC) have funded some educational programs to address these pending problems. These funded programs have been great in addressing the need to increase literacy in mathematics, science and engineering, but the focus of

these programs has been at the high school and college levels rather than at the middle and elementary school levels. It seems then that it is best and easiest to prevent such a problem from rather than to try to correct it. To better prepare minority high school students for engineering education, it seemed that an intervention program was needed at the elementary and middle school levels that will attract and continuously engage minority students in mathematics, science, engineering and technology.

To address the need to improve mathematics and science achievement of middle school students, Hampton University, in collaboration with Hampton City Public School System and NASA Langley Education Center, decided to be on the cutting edge of change by developing a mathematics, science, engineering and technology (MSET) program for socially and economically disadvantaged middle school students. This article describes the summer program and analyzes how it contributes to reducing mathematics anxiety and increasing interest in mathematics and science.

Overview of the MSET Program

The MSET Program is a model program, designed to help middle school students improve their achievement in mathematics and science. The program focused on mathematics, science, engineering and technology concepts as well as strategies to motivate students to like mathematics and science. More specifically, the long range goal of the Hampton University MSET Program was to improve the academic preparation of minority socially and economically disadvantaged middle school students so that they will be prepared to enter mathematics and engineering careers. The short range goal was to increase the number of these students who will be adequately prepared to study college preparatory mathematics and science at the high school level. The overall activities for this MSET Program were designed to increase the student's interest and achievement in mathematics and science.

The MSET Program is a three year project. Each year, the students are expected to improve and advance to the next level. Year one began during the summer, 1997, following the fifth (5th) grade of the students. At a minimum, selected students were able to read and understand science and mathematics texts at the fourth grade level as well as demonstrate their ability to

work collaboratively to design experiments based on simple observation, recording and testing of simple hypotheses. At the completion of year one of the program, which corresponded to the completion of the student's sixth (6th) school year, the students participated in a mathematics, science and technology fair. At this point in the program, the students were able to (1) read and understand science and mathematics texts at the sixth grade level; (2) read scientific instruments and keep accurate records of their findings and (3) design simple independent experiments based on observations, collect data and formulate and test hypotheses.

At the end of year two (2) of the program, which corresponds to the completion of the student's seventh (7th) school year, each student participated in a mathematics and science fair. At this point in the program, the students were able to read and understand science and mathematics texts at the seventh (7th) grade level and formulate an experimental design based on real life problems, implement that design and use the concepts of control and variable in explaining their results using current and emerging technologies.

At the end of year three (3) of the program, which will correspond to the completion of the project and the completion of the student's eighth (8th) school year, the students will again participate in the mathematics and science fair. At this time, they will be able to (1) read and understand science and mathematics texts at the eighth (8th) grade level; (2) use observation, research instrumentation and the concepts of multiple variables to produce a full fledged scientific investigation into an existing scientific or community problem; (3) publish their results in a form that includes a description of the problem (including a history of the research); (4) design a full experiment, a justification of chosen methodology and (5) design a report on the results including conclusions and directions for further research.

Curriculum Enhancement Activities

The design of the curriculum packages focused on using the Standards of Learning from the Virginia State Department of Education (SOL's), science objectives from the National Research Council (NRC) and mathematics objectives from the National Council of Teachers of Mathematics (NCTM) as well as curriculum materials from the NASA Langley Research Center.

Middle school teachers teamed with university faculty to design means of enhancing the current mathematics and science curriculum being used in the Hampton City Public Schools. They used other proven mathematics and science curriculum that have demonstrated success with minority students who have similar demographics as those who were targeted for this proposed initiative. For example, such curriculum as Windows on Science and Mathematics, Activities for Integrating Mathematics and Science (AIMS) and curriculum from the NASA Langley Education Center were integrated to enhance the curriculum packages for the program. The idea here is that middle school faculty and university faculty will focus on the aspects of science and mathematics curriculum at the middle and high school levels that will empower these students to want to study mathematics, science, engineering and technology at the high school and college levels.

MSET Summer Camp

The first Summer Camp consisted of a five (5) week academic experiences designed around important concepts that were identified by middle school instructors as critical to future success in MSET. These concepts were used by middle school and college instructors in developing and enhancing curricula for the Summer Camp. Additionally, the Summer Camp was aimed at increasing the depth and the breadth of subject matter that facilitated the mastery of these concepts that were critical to success in college preparatory MSET courses. In addition, the curriculum included a history of minority contributions in MSET. The history discipline emphasized (1) oral and written communication, (2) library usage and (3) the processes associated with conducting research. The students were exposed to practicing professionals in MSET related fields, interfaced with university personnel and university students. These activities increased the students interest in science and engineering, helped them to gather information about college and to understand college expectations.

The program selection committee, consisting of teachers, administrators, parents and professors, selected 25 students. The students attended classes on the campus of Hampton University four (4) days per week (Monday-Thursday) from 9:00 a.m. until

3:00 p.m., and Fridays of each week were devoted to field trips, museums and presentations by practicing professionals.

The Summer Camp concluded with an awards ceremony, MSET fair and a banquet for the students, parents and program participants. These activities helped students to showcase their interest and learning in MSET and developed more confidence in themselves. More specifically, the Summer Camp served as a platform for a year round effort in which the students engaged in activities that continuously enhanced their learning. It further provided opportunities for ongoing mentoring activities with upper class college students as well as provided a mechanism and support for students participation in science fairs in their respective schools.

During Week five (5) of the Summer Camp, students decided on a project in which they would pursue during the Saturday Academy on the campus of Hampton University. The same twenty-five (25) students who participated in the Summer Camp participated in the Saturday Academy. They focused on problem-solving projects which were conducted on alternate Saturdays, beginning in September, 1997. The students continued in their groups of five (5) and were tutored by upper class Hampton University students who were majoring in mathematics, science, engineering and technology. At the end of the Saturday Academy, the students again participated in a MSET fair, awards ceremony and a banquet to showcase the projects in which they had engaged. Their parents and other program participants also attended the program

The expected outcome of this project was that these efforts (1) facilitated the students studying college preparatory courses, (2) reduced the necessity for remedial course work in college, (3) aided the college in increasing its instructional delivery efficiency and (4) established role models and ancestor connection between the students and MSET.

Success of the Summer Camp

The success of the Summer MSET Camp was based on the students' attitude toward mathematics, the delivery system used and the student's performance in mathematics and science.

Positive attitude toward mathematics and science

Many students have had negative attitudes toward mathematics and science. These attitudes may stem from lack of interest in science and mathematics. This lack of interest that students have may be communicated to them by their parents and teachers; therefore, it was necessary to focus on helping students to get rid of their lack of interest and anxiety in mathematics and science. Ninety percent (90%) of the students reported that, after participating in the Summer Camp, they liked mathematics and science and had a better understanding of problem-solving concepts, were more excited about mathematics and science and were happy that they had some unique experiences on a college campus. Several parents stated that they were extremely pleased about the program and had observed their children's interest in mathematics to have increased. They also indicated that they had seen a positive difference in their children's attitude toward school in general.

Delivery system: Hands on mathematics and science

The delivery system of using hands-on mathematics and science strategies was very exciting to the students. The were involved in a laboratory type setting where in they engaged in several activities that required them to focus on problem-solving, divergent, analytical and critical thinking skills. For example, the students designed and computed the necessary mathematics that was needed to construct a wind tunnel; used graphic calculators to compute and graph the number of different colors of fruit loops that were in a box of cereal and were engaged in activities that involved electricity and electromagnetism. In fact, the students were involved in a variety of hands-on activities in mathematics and science.

Student achievement and improvement

Eighty-five percent (85%) of the students who participated in the Summer Camp reported that they now like mathematics and science better after having participated in the program. According to the students, 95% reported that they were more interested in mathematics and science homework. Research shows that when students like mathematics, they are more likely to improve and their achievement level will increase.

The students may have improved in mathematics because they liked the non-traditional classroom activities that were used to teach them how to solve problems, how to use inquiry techniques and how to apply deductive and inductive reasoning and thinking skills. The professors also challenged the students to work in cooperative groups and teams, to communicate with each other, to solve problems that made sense to them and to solve problems that required them to apply the theories learned to real life situations. Ninety (90%) percent of the students reported that these activities were innovative and exciting, and they enjoyed being involved in activities that related to the practical application of mathematics and science.

Implications for Middle School Students

The implications from this Summer Camp for middle school students may be viewed from several perspectives. First, socially and economically disadvantaged students should be exposed to hands-on mathematics and science at the middle and elementary school levels. In fact, research shows that students who understand mathematics and science at an early age are more likely to achieve and perform higher in these subjects (NCTM, 1998; NASA, 1997 & Steen, 1990). Secondly, the field trips provided an opportunity for the students to see real scientists and to understand how they use mathematics everyday. Some students were surprised that mathematics is a tool that is used in all areas of the world to solve problems and to know that the basis for understanding mathematics is to solve problems rather than just compute. Third, the students had an opportunity to use calculators to assist them in solving the mathematical problems, rather than spending their time computing manually, and fourth, the students seemed to have been excited about being on a college campus. Ninety percent (90%) of them stated that the program was successful, and they enjoyed it and would return for another summer in the program.

Conclusion

The MSET Program for socially and economically disadvantaged students was unique and innovative for several reasons. First, rising sixth grade students were exposed to

techniques that allowed them to perform as scientists, mathematicians and engineers. Secondly, fifth grade students had an opportunity to use hands-on science and mathematics to solve problems that they faced in designing and constructing as engineers. Third, these students had an opportunity to work in cooperative groups as team members and to interact with each other, to communicate and share knowledge with each other, to be involved in self paced learning strategies and to work at their own speed to fuse mathematics and science concepts to solve problems that they faced in completing their projects, and fourth, the student's had an opportunity to showcase their projects to the community and their parents at a closing and awards banquet.

Although the MSET Summer Camp could not guarantee to students or parents that the students would improve in mathematics or science or would even change their attitude about the subjects, the Summer Camp did provide valuable information to the professors and project staff. For example, the Summer Camp provided an opportunity for the students (1) to be exposed to new and innovative ways to learn mathematics and science; (2) to see how mathematics is a tool and can be used to solve everyday problems for scientist and engineers; (3) to view mathematics in a different light and to be ahead of their peers in geometry, probability and statistics during the academic year and (4) to have fun with science and mathematics without the fear of failing or having to worry about receiving a grade. The success of their work was based on how well they completed their projects and to what extent they were able to talk to others about what they did and their projects.

In conclusion, the Summer Camp showed that 90% of the middle school students reported that their attitude toward mathematics and science had changed and that they now liked the subjects. It is reasonable to conclude that the Summer Camp provided an opportunity for students to improve in mathematics and science, an increase in their achievement level, and a change in their attitude toward the subjects. The Summer Camp is a concrete, viable and successful model that builds on the Professional Teaching Standards of Mathematics, the Virginia Standards of Learning and the Mathematics and Science Standards of the NCTM, NRC and NSTA.

The Summer Camp for middle school minority students was our intent to provide an opportunity for socially and

economically disadvantaged students to be exposed to new ways of learning mathematics and science, to be exposed to scientists and engineers who use mathematical concepts everyday and to increase their achievement level in mathematics and science at the middle school level.

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