NASA/CR-97- 206154

INTERIM
IN-80-CR
OCIT
090724

Santa Clara University
Educational Administration
Bannan Hall, Room 228

NASA Grant Title: Increasing Mathematics and Science Achievement for Culturally Diverse Students Through Teaching Training

Type of Report: Performance Report at the conclusion of Two Years

Principal Investigator: Dr. Lee Mahon
Director
Educational Administration

Period Covered: 1995-1996 and 1996-1997

Institution Address: Santa Clara University
500 El Camino Real
Santa Clara, CA 95053

Grant Number: NAGW # 4245

The purpose of this proposal was to field test and evaluate a Teacher Training program that would prepare teachers to increase the motivation and achievement of culturally diverse students in the areas of science and mathematics. Designed as a three year program, this report covers the first two years of the training program at the Ronald McNair School in the Ravenswood School district, using the resources of the NASA Ames Research Center and the California Framework for Mathematics and Science.

Target Population

The target population included teachers, administrators, and paraprofessional aides from the Ronald McNair School in the Ravenswood School District. Participants were invited to attend a series of work sessions designed to increase their effectiveness in the teaching of math and science for middle school students.

The Ronald McNair School is a fifth through eighth grade middle school, one of eight serving the population of East Palo Alto and east Menlo Park. The student population at the Ronald McNair school is rich in its ethnic and cultural diversity. There are 512 student - 40% African-American, 52% Hispanic, 5% Pacific Islander and 2% Hindi and other. Approximately 33% are Limited English Proficient. The population is highly mobile and there is a steady increase in immigration, primarily from Mexico and Central America.

The Problem

Goal Four of the National Goals for Education states that by the year 2000, United States students will be first in the world in science and mathematics. When we examine the overall achievement of American students, this goal is quite realistic for about 20 percent of our brightest and best. In fact, out public schools are preparing about 20 percent of our top high school students at world class levels.[1] These students tend to be middle class, Anglo and Asian, and attend schools in more affluent communities. The advantages of this group are multiple in that family effects, access to experiences which require more family income, and a higher quality of schooling are combined to enhance student achievement. This group is slowly but steadily becoming more diverse and they will continue to get better over time.

The next forty percent of students learn basic skills and are capable of college work and productive lives. Some need assistance in mathematics, science, and writing but they are capable of high levels of learning. This group includes a considerable number of minorities and low income students, and often, the members of these groups are the first in their families to attend college.

---

[1] Harold Hodgkinson, "American Education: The Good, The Bad, and The Task." Phi Delta Kappan April, 1993, pp. 619-623.

The lower 40 percent of our students are those whom schools do not serve well. These students are more likely to be poor, Hispanic or African American, and reside in communities that tend to be poor and often do not provide essential learning resources. The achievements of this lower 40 percent is not a function of ability. It is the result of a complex number of factors that limit achievement. Some of the more powerful factors involved are the social problems and conditions of their lives, including poverty and the quality of the schools found in their communities. Further, the policies, practices, attitudes and behaviors of school personnel in the classroom and the school often contribute to the limited achievement.

The social problems and conditions facing many children today are well known. Low achievers tend to be poor (nearly one fourth of our children), suffer from inadequate health care and nutrition, live in dysfunctional families and frequently, in violent neighborhoods. If these children are to achieve, schools and communities must work together to provide a "seamless web" of health, nutrition, social welfare, psychological help, day care, early childhood education, and job training services.

The second major factor in differential achievement is the differential access to the resources of high quality schools, teachers and instructional materials. A study by Taylor and Piche[2] documented the inequality of resources for disadvantaged students, which was summarized in the following statement:

> "It is not unusual for economically disadvantaged students in these (poor) districts to enter school without preschool experience, to be retained in the grades without any help in reading, to attend classes with 30 or more students, to lack counseling and needed social services, to be taught by teachers who are inexperienced and uncertified, to be exposed to curriculum in which important courses are not taught and materials are inadequate and outdated."

The further documentation of the inadequacies of urban and suburban schools serving low income children is provided by Aspy and Roebuck.[3] Their study points out the differential in courses, in equipment and materials, in teacher preparation and experience, and in a general low expectation for poor and minority achievement of students in science and mathematics.

It is comparatively difficult for any single group to deal with the issues outlined above, but there is good news in that educators can make a strong, positive contribution to overcoming some of these barriers.

---

[2] W. L. Taylor and D.M. Piche. A Report on Shortchanging Children: The Impact of Fiscal Inequality on the Education of Students At Risk. Washington, D.C., U. S. Government Printing Office, 1991.

[3] D. Aspy & F. Roebuck. Kids Don't Learn From People They Don't Like. Amherst, MA: Human Resources Development Press, 1983, p.5.

NAEP data[4] suggests that the great majority of students, including minority and female students, are interested in science and mathematics in the elementary school. Student interest begins to decline at 6th grade and their participation in mathematics and science courses and activities continues to decline at middle school and high school.

Why this decline? There are many factors to be considered but some of the most important include the following:

- o Teacher Expectations and Interpersonal Skills

  Teacher expectations are the inferences that teachers make about the future academic achievement of students.[5] This expectation effect is sustained in situations where teachers fail to see students' potential and do not respond in ways to encourage them to fulfill their potential.[6] The way we eliminate this differential achievement is for teachers, administrators and parents to **believe** that all students can achieve at high levels. The importance of these expectations is highlighted by Brophy's estimate that from five to ten percent of the variation in student achievement is the result of differential treatment based on teachers' differential expectations of students.[7]

- o Language and Literacy

  Language development is one of the most critical tasks of schooling. The most powerful predictors of academic achievement are vocabulary development and comprehension. One of the problems for students in the lower 40 percent is that they often have some 2,000 fewer words in their vocabulary than middle class children when they begin school.[8] The vocabulary gap continues to expand as children go through school. Many of the lower 40 percent continue to fall farther behind in their achievement as they progress through the grades. At third grade, the differential between the lower group and middle class students is likely to be 5,000 words; at seventh grade it has grown to 10,000 words and by grade 11 it is 20,000 words. This vocabulary differential is crucial to the study of mathematics and science. If the student has a limited basic vocabulary, it is unlikely that he/she will understand abstract concepts essential for mathematics and science comprehension. Unless a special effort is made to find

---

[4] National Assessment for Educational Progress, Educational Testing Service, 1993.

[6] T.L. Good and J.E. Brophy. "Teacher Expectations," In Looking in Classrooms. New York, Harper and Row, 1984, p. 84.

[7] J. E. Brophy. "Research on the Self-Fulfilling Prophesy and Teacher Expectations," Journal of Educational Psychology, #75. 1983, pp 631-661.

[8] M. Smith, quoted in W.E. Nagy. "Limitations of Vocabulary Instruction." IL: Center on Reading, University of Illinois.

ways of ensuring understanding, simply repeating the terms will not make a difference. Models, illustrations and hands on experiences are needed and these are not often a part of the teacher' s repertoire of skills.

- o Instructional Methodology

  Comparatively little attention has been given to the need for a variety of instructional methods especially when working with culturally diverse students. The basic instructional model in American schools is structured instruction or the presentation of ideas, assessment, and feedback. It is estimated that 80 percent of the instruction students receive follow this model. While the model is appropriate for some students and some learning tasks, it does not recognize the diversity of learning styles, including cultural learning styles, that students bring to the school. Teachers need to use a wide variety of instructional styles to a) allow students to use their preferred learning style and b) help them learn other learning styles. Another aspect of instruction which must be addressed is the need for active hands on, skills-based learning. This is especially true in the areas of science and mathematics, and NASA Ames Research Center was a vital element in providing this type of instruction.

- o Curriculum

  Efforts have been made to provide a powerful, coherent, curriculum for California students. This curriculum is outlined in the California Curriculum Frameworks for science and mathematics. These frameworks provide important directions for curriculum but they are often not aligned nor included in the local curricula. Although the frameworks have made some effort to include multicultural content, more must be provided to increase the interest and motivation of minority students.

  The tasks of the curriculum effort allowed us to a) to ensure alignment and activities which were consistent with the California frameworks, b) to infuse multicultural information and concepts into the content area, and c) to take advantage of scientific and mathematical resources available through the NASA Research Center in developing a curriculum model.

The Program

These four areas -- teacher expectations and interpersonal skills, language and literacy, science and mathematics instruction, and science and mathematics curriculum -- were the four essential components of the classroom experience. The overall goal was to enhance teacher effectiveness and their ability to teach science and mathematics, successfully, to all students.

The focus of the proposed project was a training intervention for teachers in the Ronald McNair School in the Ravenswood District that would serve to increase the science and mathematics achievement of students. The project assessed instructional and materials needs and identified ways for teachers to avail themselves of these materials. This included items such as multicultural books, manipulatives, science materials, etc.

In the past, through an Adopt-a-School partnership with NASA Ames Research Center, McNair teachers had the opportunity to supplement their science backgrounds through field trips and inservice from NASA Ames's education outreach department. The whole identity of the Ronald McNair School is tied to NASA Ames and strongly linked to space science. Study trips, curricular materials, films, slides, and other resource materials including NASA broadcast of shuttle launches and landings were to be integrated into this model for the greater achievement of success in teaching math and science.

The plan to achieve the overall goal of this proposed project included offering a series of training sessions including classroom coaching, hands-on materials and identification of same, use of computers in science and math, and strategies that to increase the mathematics and science achievement levels of culturally diverse students.

The first two to three months of the project were spent working at the school site with individual teachers assessing their strengths and area of needed improvement. During the early summer months the staff worked to plan and develop a program which involved a full week "hands-on" workshop for all faculty members in August. With the assistance of the staff from the Ames Research Center, a new curriculum was developed and an assessment of needs and practices were defined. Working with Ms. Laura Shawnee of the NASA Ames Research Center, provided complete information and resource availability to the project.

In August of year one and year two, a five day worksession and training program was prepared and implemented for 20 teachers and 2 administrators.

The Plan

The plan for the second year of the project was to offer a full week training session at the Ron McNair School for approximately 20 teachers and 2 administrators, and to follow-up this week long session with six additional one day/month sessions culminating in February/March with a two day weekend session. All sessions were designed to provide hands-on materials and/or demonstrations on how hands-on materials can be made and used effectively, and to assist the teachers identify strategies that would increase their mathematics and science achievement in order that by the end of three years, they might be better prepared to increase the mathematics and science achievement levels of culturally diverse students.

The plan for the third and final year of the project will be to continue to work with approximately 20 teachers and 2 administrators using technology and the resources of the NASA

Ames Research Center in a distant learning pilot project and how best to work with students using technology to provide the skills required for math and science achievement.

Objectives and Activities

The objective and activities which helped shape the project included, but were not limited to the following:

Objective: To examine and refine existing training materials from NASA Ames Research Center and State of California curriculum frameworks, and to provide teachers with examples and models of relevant, multicultural, skills-based science and mathematics instructional strategies.

Activities and Assessment: Existing training materials from NASA Ames Research Center as well as materials used in the classrooms at the Ron McNair School and California Curriculum Frameworks were reviewed and evaluated. In some instances, the materials at the school district were still somewhat outdated which immediately served as a hindrance to the science and mathematics emphasis we were attempting to implement. With the assistance of the administration and staff of the Ron McNair school, all obsolete materials were gradually replaced with current science and math materials from the Ames Research Center and from some of the local foundations who supported the acquisition of a new curriculum.

It was also determined that due to a very large number of new teachers assigned to the school, there was a need to review some basic mathematics skills with the teachers in addition to a time spent on interpersonal communication skills with children. It seemed far more appropriate for us as trainers to help the teachers obtain these skills then move on to the new and strategic concepts needed to teach middle school students.

With the assistance of volunteer graduate students at Santa Clara University and Project Staff, specific concepts in mathematics were identified in the California Frameworks and were matched with the strategies of the Power Teaching mathematics program to bring additional help through strategies and basic concept drilling, for the teachers at the Ron McNair School.

The materials covered included:

I Differential achievement -- What do we know about equalizing achievement?

II Our expectations and behaviors -- How have they influenced achievement and how can we overcome their impact?

III Cultural basis of achievement -- learning styles and how we learn.

IV Instructional Excellence -- delivering math and science content to children.

The evaluation by the teachers on a scale of 1 to 5 (5 being the highest) was between 4 and 5, however, by the second and third sessions, although the evaluations remained high, we discovered that the basic skills and strategies we had sought to provide in the first worksession needed to be reinforced, particularly in light of our plans to gradually move this group of

teachers into the realm of technology. Many of the teachers were unable to grasp the concepts. Philosophically, the teachers agreed with the program, but grasping the concepts seemed to be more difficult.

On the fourth and fifth day of the workshop, Dr. Stanley Pogrow was invited to provide an inservice training program at the Ron McNair School on mathematics and science skills through the use of computers - a highly successful program.

During the second year of this project we initiated a number of hands-on strategies in mathematics and involved the teachers in small group sessions where they resolved problem areas involving mathematics. Throughout these session we provided a diagnostic outline of curriculum and instruction that called for teacher implementation in the following areas:

V. Language and teaching comprehension -- mastering the language of mathematics and science.

VI. Curriculum development -- from outcomes to activities and skills.

VII. Instructional excellence -- delivering mathematics and science content in effective ways.

Each session has been and will continue to be practice oriented designed to provide knowledge, strategies, and skills which can be used in the classroom. A variety of training methods have and will continue to be used -- assessment activities, information sessions, skill building activities, small group activities and group discussions. At each session teachers will be asked to report on their use and share their findings.

At the end of the three year program, the resulting product will be the development of training materials, demonstration curriculum, activities and other resource materials in mathematics for teachers throughout the district.

Project Outcomes and Impact

The anticipated impact and outcomes of this three year project will be as follows:

o Products

• Developing new training materials that will focus on the four levels of teacher expectations and interpersonal skills, mathematics instruction and science.

Ongoing process

- An ongoing network of trained educators to further disseminate the activities of the project.
- Increased teacher skills for teaching mathematics and science
- Interfacing of NASA Ames Research Center instructional materials and the California Curriculum Frameworks in Science and mathematics -
- Increased teacher ability and skills in science and mathematics.

During the first half of this project, we worked with approximately 12 teachers who each had a class size of approximately 32 students. Initial impact for students 12 x 32 = 384 students. During the second year we worked with 20 teachers who will be impacting more than 500 students. During the third year of this project, with at least 20 teachers participating, the impact on students should continue to grow, as the class size grows, 20 x 35 students = 700 plus. The second year of the project included Science and Math Mentor teachers from the district who provide additional assistance to other teachers and inevitably other students.

Thanks to the resources of the NASA Ames Research Center, we will be working with Ms. Laura Shawnee and Mr. Aaron Hatch in at least one new "Distant Learning" program as we pilot materials developed by the NASA Ames Classroom of the Future.

Unique Capability

The proposed project will be carried out through the auspices of the Educational Administration program at Santa Clara University, a program that specializes in teacher training and carrying out projects to support educational institutions. Dr. Lee Mahon, Sherry Herrgott, and Dr. Shirley McCune are the principal staff and have the support of other experienced educators or consultants that may be called upon to assist in the implementation of the project.

Dr. Mahon, who serves as the Principal Investigator for the project, is the Director of the Educational Administration and Masters Degree program at Santa Clara University. She has a wide variety of experiences as a teacher, a vice principal, principal, and director in a variety of multicultural setting in the San Francisco Unified School District. She has also been the project director of a number of educational equity projects and has served as a trainer and presently a university faculty member.

Dr. McCune is the president of Learning Trends, an educational consulting firm. She is nationally known for her work in educational equity, teacher training, school leadership, materials development, and educational policy. Dr. McCune publishes her own newsletter on curriculum and instructional strategies and will be chiefly responsible for the teacher training portion of this project..

Sherry Herrgott, Project Liaison serves as the liaison between the Ravenswood School District teachers and Santa Clara University. She will serves a dual role as evaluator of the Project, attending each of the workshop sessions as well as visiting the classrooms and technology centers of the Ron McNair School and other schools involved in the program. Sherry is a part time staff member of the Educational Administration program at Santa Clara University and works closely with Dr. Mahon in meeting the needs of teachers in the field.