PROGRAM TO ENRICH SCIENCE AND MATHEMATICS EXPERIENCES OF HIGH SCHOOL STUDENTS THROUGH INTERACTIVE MUSEUM INTERNSHIPS

DOE/ER/75967--T1

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DISCLAIMER

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From high school, through college, and into the professional work force, we find a decreasing proportion of minority-group and female representation in science, mathematics, and science-related areas. Nationwide, as reported in 1989, approximately 30 percent of students were minorities. In Charlotte Mecklenburg Schools (CMS), North Carolina, Black, Hispanic, and Native American students comprise 40 percent of the student population. By the year 2000 it is expected that about half of the students will be minorities (Weiss, 1989).

While school population trends show increased proportions of Blacks and Hispanics, American schools fall short in preparing young people, especially minority children, to perform in a society that is increasingly dependent upon science and technology. The implication is that the nation's future will come to depend more strongly on minority groups and minority-group participation as population demographics change (AAAS, 1989). In directing its recommendations for reform of science, mathematics, and technology education toward the total school population, Project 2061 acknowledges that ethnic minority and female students have been neglected in the science education process (AAAS, p.20).

One result may be crucial work force shortages in the future. Anderson (1989) points out that, in this country, between 1985 and 2000, approximately 25 million people will join the work force in jobs that more and more require higher degrees of scientific and technological literacy. White males will comprise about 15 percent of these; white males presently constitute about 85 percent of scientists and engineers. By the year 2006, more than a half million of the current science and engineering positions will be vacant if the pool of candidates from which those positions are filled is not enlarged. The National Science Teachers Association has established a division to address multicultural concerns such as the need to encourage underrepresented groups, including blacks, Hispanics, and women, to pursue science-related careers. A second concern addresses the need to recruit students of all minorities to consider science teaching as a career.

A recent RAND corporation report examined learning opportunities provided for minority students. The investigators examined survey data from 1200 public and private schools and 6000 teachers. In general, minority (black and Hispanic) students have less access to computers and science laboratories and equipment; school principals report that limited resources interfere with instruction in science and mathematics. Disadvantaged students have less exposure to courses and strategies that promote interest and achievement in science and mathematics. It is less likely that these students will be able to pursue careers in science or mathematics (NSTA, 1991).

At the high school level, females are much less likely than males to consider science enjoyable. The number of students who think that science classes are enjoyable decreases from seventh to eleventh grade, with that decline being greatest for black students (Weiss, 1989).

In addition, male secondary science students are more likely to believe that they will use science as an adult than female students. Also, male students have greater expectations of working in an area that requires knowledge in science and mathematics than female students. Differences between male and female performance in the physical sciences, and differences between performance of white students and minority-group students in chemistry, life sciences, and physical sciences are large. Differences for similar groups in mathematics proficiency exist but are not as great as for science areas (Weiss, 1989).

The increased cultural diversity of the student population and under-representation of minorities and females in the technical and scientific work force are matched by needs for a more representative teaching force. Many of the representational disparities that are recognized today may be related to a lack of suitable role models at crucial periods in a student's education. While about 30 percent of students are minorities, less than 15 percent of teachers are minorities (Weiss, 1989). Atwater (1989) identifies the recruitment and training of science teachers of high quality, including minority teachers and the provision of greater access to science experiences are two critical needs recognized in A Nation at Risk.

Findings of a recent study of college of education placement and school district employment patterns indicate that the number of new classroom teachers graduating from colleges and universities has "...reached its lowest level in 20 years." The decline in the number of new teachers is coincident with an increase in the birth rate in the United States. One result is the prediction of teacher shortages in the near future. Heading the list for those in short supply are minority teachers, followed by teachers in areas of science, such as physics and chemistry, and mathematics (NSTA, 1992).

In North Carolina, projections of teacher supply and demand indicate that we are experiencing teacher shortage; more new positions are expected than graduates from North Carolina colleges and universities can fill. This is particularly true for the fields of mathematics, computer education, chemistry, physics, and general science. With the exception of general science, these shortages are expected to be severe.

These shortages are even more dramatic when examining minority classification. In 1985-86, blacks made up 19 percent of the total public school teacher work force, but only about 12 percent of the new hires were black. Considering all of the new hires for the 1985-86 school year, only 8.9 percent were graduates of North Carolina colleges and universities. The proportion of blacks in computer education, for the same year, was lower than the overall proportion of blacks in the teacher work force, being only 15.3 percent. In mathematics and computer education, 8.5 percent of new hires were black, and 4.5 percent of these were graduates of North Carolina teacher preparation programs. For all science teachers, the comparable figures were 16.9 percent for the total number of science teachers, 7.1 percent of the new hires, and 1.8 percent of the NC science teacher graduates. In fact, only two of the newly graduated science teachers who were hired by a North Carolina public school in 1985-86 were black (Banes, Bass, and Wakeford, 1986).

To compound the problem, minority-group teachers are leaving the teaching profession, and the number of new ones entering the profession is decreasing. Despite efforts to enhance minority participation in science and engineering, blacks and Hispanics continue to be under-represented in these areas. Blacks constitute about 14 percent of the U.S. population, but earn only about 4 percent of the baccalaureate degrees in science and engineering. Similarly, Hispanics earned only about 2 percent of the baccalaureate science or engineering degrees but comprise about 8 percent of the population (Weiss, 1989).

The disparity between the number of minority-group children and minority-group teachers is growing. This suggests practices that encourage girls and minority-group children to achieve their full potential in mathematics or science should be encouraged. This includes providing female and minority teachers as role models. A National Research Council report recommends that colleges and universities pay greater attention to recruiting women and minority group members into careers in science and science teaching (National Research Council, 1990).

In a news report, NSTA (1989) indicated renewed interest in providing funding for programs to encourage minority participation in science. The report describes one cooperative project involving several colleges and universities, the New York Hall of Science, and the New York City Board of Education. Students take science courses at the universities while working as part-time "explainer" at the science museum. The students ultimately earn degrees in science and education; the program is designed to address the science teacher shortage in New York City.

In a study by Mulkey and Ellis (1990), minority high school students who participated in intervention programs designed to increase science ability and interest in science careers were compared to similar students who were not participants in these intervention programs. Programs included parent workshops, science clubs, supplemental classes in math and science, tutoring, and career counseling. The participants completed more classes in science and math and were more likely to graduate from high school. Significantly more participants in the program enrolled in college than non-participants.

In yet another program, high ability minority students participated in a Saturday Academy, which offered enrichment courses in electrical engineering, computer science, and mathematics. Participants were compared to an equivalent control group with respect to high school graduation, college enrollment, and choice of major field of study in college. The intervention program was apparently successful in enhancing both the high school graduation rate and college entrance rate. A slightly greater percentage of Saturday Academy participants selected science or mathematics related majors than control group students who entered college. Recommendations for effective programs included participation in out-of-school activities (Hayden and Gray, 1990).

The pre-college program offered by the mathematics and Science Education Center at the University of North Carolina at Charlotte (UNCC) provides enrichment activities in science, mathematics, and communications to underrepresented junior and senior high school students (minorities and females). Like other intervention programs, the goals of this program are to increase participation and achievement in science and mathematics classes, enrollment in college, and pursuit of science-related careers. Components include a Saturday Academy, Summer Scholars Program, academic enrichment clubs, and tutoring (MSEC, 1991).

In 1991, approximately 300 students participated in the program. All of the high school seniors enrolled for two or more years in the program (19) graduated and were accepted by one or more colleges. Problems that have been recognized by program designers include diminished retention of white females and black males, due perhaps to other interests such as jobs and athletics, and the lack of appropriate role models (MSEC, 1991).

The Project

This project addressed the problem of female and minority representation in science and mathematics education and in related fields. It was designed to recruit high school students from under-represented groups into a program that provided significant, meaningful experiences to encourage those young people to pursue careers in science and science teaching. It provided role models for those students. It provided experiences outside of the normal school environment, experiences that put the participants in the position to serve as role models themselves for disadvantaged young people. It also provided encouragement to pursue careers in science and mathematics teaching and related careers. In these respects, it complemented other successful programs to encourage participation in science. And, it differed in that it provided incentives at a crucial time, when career decisions are being made during the high school years. Further, it encouraged the pursuit of careers in science teaching.

The program involved female and minority high school students working through museum-sponsored science clubs and enrichment programs to provide science experiences to young people. In the science clubs, participants worked with approximately 130 inner city youth. Through museum camp-ins, the program had the potential of enriching the science and mathematics experiences of hundreds of young people.

Further, this project supported and provided follow-up activities for funded intervention programs. Some of the participants in this project were involved in various aspects of the UNCC Mathematics and Science Education Center Pre-College Program. In addition, other participants were identified from the Sci-Teen program at the Discovery Place Museum. In addition, a major activity included involvement with Science Clubs, a Science Museums of Charlotte program funded through the DeWitt Wallace-Readers Digest fund YouthALIVE! initiative.

Project Objectives:

The objectives of this project were to:

1. Provide enrichment instruction in basic concepts in the life, earth, space, physical sciences and mathematics to selected high school students participating in the program;
2. Provide instruction in teaching methods or processes, including verbal communication skills and the use of questioning;
3. Provide opportunities for participants, as paid student interns, to transfer knowledge to other peers and adults;
4. Encourage minority and female students with high academic potential to pursue careers in science teaching.

Design of program and procedures:

The intern program had five basic components: recruitment, training, museum activities, monitoring, and evaluation.

A. Recruitment

Participants were eighteen minority and/or female high school science students in the first year, and twelve in the second year from the Charlotte Metrolina area, including Mecklenburg, Gaston, Anson, Cabarrus, and Union counties. Criteria for eligibility included:

a. junior standing
b. 16 years of age minimum
c. grade average of B or better overall
d. two credits/units of high school mathematics and two credits/units of high school science completed in grades 9 and 10
e. grade average of B (or equivalent) in math and science
f. recommendation of a science or math teacher attesting to the potential of the student to be a teacher

Selection preference was given to students who had successfully participated in other enrichment programs such as Sci-Teens, Summer Ventures, Saturday Academy, or Explorer programs provided by school districts, mathematics and science education centers, or museums.

B. Training of Paid Student Interns

a. Training sessions were held once a month, on Thursday evenings. and they were two hours in length. Special training sessions in museum procedures were provided by Discovery Place staff to adequately prepare participants for museum service. Participants had to provide their own transportation to and training sessions.

b. Training sessions were held at Discovery place, and focused on museum activities with which the participants worked. Ten training sessions provided by UNCC instructors were conducted, beginning in September of the project year. Five sessions focused on the science content related to museum activities and five sessions dealt with communication and questioning strategies they employed when interacting with museum visitors. Topics for these sessions included what is good teaching, instructional design, gender differences in math and science, misconceptions in science, technology, science projects, and futures in science education. These concepts were consistent with the science club activities and with what students learn in the overnight field trips. Discovery Place personnel monitored what the students taught and they provided corrective assistance when needed. Museum staff provided training session topics that were mandatory for museum staff or deemed necessary by Discovery Place.

c. Participants were informed of incentives (scholarship or loan programs such as North Carolina Teaching Fellows) available to students of high potential in math or science pursuing teaching careers.

d. Attendance at these sessions was mandatory.

C. Museum Activities

a. Participants worked as Paid Student Interns in programs or facilities operated by Discovery Place.

b. Work assignments began after one or two training sessions. Work assignments were determined by museum needs and assignments. Interns assisted with science clubs and in the Camp-In program. These museum activities allowed the student interns to interact with younger students or adult museum visitors in an instructional capacity. Interns worked at constructive, instructional, and worthwhile tasks. Project participants were taught how to keep journals to document personal growth and to record reflective discussions about teaching as a career. Pedagogical techniques were continuously reviewed and discussed with the participants. Videotaping of science club and overnight field trip activities provided visual records of participant interactions.

c. Student interns were involved with museum work for a maximum of twenty hours per month, and nominally for eight months. All internships were completed within one year. This allowed interns to expend their work calendar into the summer months to meet program goals and museum needs.

D. Museum Programs

a. Science clubs sponsored by Discovery Place had been established in seven inner city neighborhoods or schools with significant populations of disadvantaged youth. Science clubs met twice per month and currently involved approximately 130 young people 10-12 years of age. A science educator supervised the clubs and activities. Activities presented were interactive and were intended to promote inquiry and reinforce higher level thinking skills. Clubs met in a variety of community based settings.

b. Camp-Ins in the Discovery Place museum took place from October through May. Camp-In participants arrived at Discovery Place on Saturday afternoon and left around noon on Sunday. The groups that participated in Camp-ins included scout groups, school groups, and science clubs. Camp-In activities, planned by Discovery Place staff, included hands-on interactive exhibits, a science assembly, show, and a visit to the Discovery Place Planetarium and Omnimax Theater.

E. Project Description

Arrangements were made with Discovery Place, an interactive science museum in Charlotte, North Carolina, to involve project participants as paid interns. The interns were trained by Discovery Place staff in museum and safety procedures. The interns chose to assist in science clubs around the city sponsored by Discovery Place, or to participate in museum Camp-In programs. Interns who chose to work with science clubs assisted the science teacher, tutored club members, and taught science activities. Those interns who elected to work with the overnight camp-ins (and most of them did), developed science activities with smaller groups of students and worked with campers in a one-on-one setting. They often assisted museum staff with presentations. The interns became proficient in at least one of the science areas that comprise the museum program.

The project was carried out during the 1994-95 and 1995-96 school years. For each of the project years, project staff prepared publicity and application materials, and distributed those materials to high schools in the five county region in and around Charlotte. Materials were first distributed near the end of the 1993-94 school year. It was hoped that applicants could be screened and introduced to the program in order to participate during their senior year in high school. However, initial response was slow. The main problem was identifying key contacts at schools who could get application materials to interested and eligible students.
Through continued efforts at publicizing the program, a sufficient pool of applicants was obtained. Applicants were screened for basic qualifications, including science and math background, level of schooling, grades obtained, and gender and ethnicity. Discovery Place staff then interviewed the applicants. Twenty applicants were accepted as interns during the first year; subsequently, two of these declined to participate. In the second year, participation was limited to twelve interns. During year one, 14 female and 4 male students became participants, and in year two, there were 12 students, 10 female and 2 male. Students were all from under-represented groups in science and science education.

Receptions were held at Discovery Place to introduce interns and their families to the program. One benefit to the participants was a one year family membership to the museum.

Museum and project staff described the program and museum activities, and invited the new interns to participate in some hands-on science demonstrations.

Beginning with the fall semester, the interns were taken through a museum-training program for volunteers. They were introduced to the North Carolina Fellows program, a competitive scholarship-loan program for high school graduates of high quality who want to become classroom teachers. Through monthly meetings, they were introduced to science inquiry activities, journal writing, technology, and teaching techniques.

F. Evaluation

The project's four main objectives were designed to take a group of able minority and female high school juniors, train them to understand basic science principles, provide them with simple pedagogical instructional techniques, and place them as teaching assistants in science clubs for disadvantaged youth and in overnight science field trips at Discovery Place. The program participants were to learn to understand basic science concepts, explain what they had learned to other students, and explore the value of mathematics and science teaching as a career.

Program evaluation was designed to measure how well the four program objectives were met. The following assessments were carried out to evaluate attainment of Project objectives:

a. Pre-assessment of science knowledge. This was accomplished by a tour of Discovery Place, with discussion of specific exhibits.
b. Pre- and post- inventory of attitudes toward science and science teaching.
c. General assessment of intern performance, conducted by Discovery Place.
d. Follow-up surveys to determine the number of participants who enter college, apply for teaching scholarships, and declare science or math teacher preparation as a major or concentration.

Three forms of program evaluation were used. First, interns were observed and interviewed during the term of the project. Second, attitudinal surveys (see Appendix) were administered to the interns at the beginning and at the end of their term of participation in the program. The surveys examined career preferences, interests in schooling, and attitudes toward science and the teaching of science. Of particular interest were changes in attitude reflecting attainment of the goals of the project. This information was collected by means of an interview schedule with selected participants (see Appendix). Third, follow-up studies were planned to determine which of the interns continued their studies at the college level and their choices of major area of study in college. We also wanted to know if any of the interns applied for and received science or science related scholarships.

The attitudinal surveys consisted of three parts. In the first part, the interns indicated an interest level for each of twenty-seven career choices, and ranked those for which the interest level was high. Careers or occupations rated highest at the start of the program were medical doctor and biologist, followed by science teacher, chemist, and architect. At the conclusion of the program the three highest ranked career choices were biologist, science teacher, and medical doctor. In general, beyond those choices there was no clear distinction in preference of scientific or technical careers over the others, nor was there any significant change in the ranking of teaching careers. While the ranking of math teaching increased as a career choice increased, the rank of medical doctor decreased.

The second part of the survey called for a rating of the relative importance of different aspects of schooling. The most important aspects of their school experience were technology, science, communication skills, and socialization. On the post survey, science and communication skills remained at the top of the ranking. Again, there were no significant trends reflecting a change in the data.

The final part of the survey examined attitudes toward science and science teaching. The data indicate that attitudes toward science were very positive among both groups of interns. Attitudes toward science teaching, while positive, were not as strong when compared to science as a field of study. An examination of items indicated that the responses were consistent throughout the survey. There were no significant changes in attitudes toward science or science teaching over the course of the project.

Interviews conducted at the end of each year of the project were perhaps more indicative of the success of the program. All of the interns from both groups applied and were accepted into university programs. All but three enrolled in science and/or teacher education programs. Two of the interns applied for and received North Carolina Teaching Fellow Scholarships. The interviews revealed that the interns could present and explain science material to children, and they were convinced they could explain concepts and accurately answer children's science questions.

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Appendix

CAREER INTEREST SURVEY

CAREER INTEREST SURVEY

Code number ________

1. Please indicate, by writing an X in the appropriate blank at the right, the level of interest you have in each of the careers or occupations. Please rank those you marked as "High Interest"; use "1" for the career in which you are most interested, "2" for the next highest interest, and so forth.

	Interest			Rank those marked High
	High	Med	Low	
attorney	____	____	____	____
accountant	____	____	____	____
computer programmer	____	____	____	____
real estate	____	____	____	____
mechanical engineer	____	____	____	____
coach	____	____	____	____
medical doctor	____	____	____	____
video technician	____	____	____	____
science teacher	____	____	____	____
photographer	____	____	____	____
biologist	____	____	____	____
dancer	____	____	____	____
newspaper reporter	____	____	____	____
film maker	____	____	____	____
math teacher	____	____	____	____
public safety officer	____	____	____	____
electrician	____	____	____	____
social worker	____	____	____	____
chemist	____	____	____	____
commercial artist	____	____	____	____
carpenter	____	____	____	____
textile worker	____	____	____	____
electronics technician	____	____	____	____
architect	____	____	____	____
machinist	____	____	____	____
clothing designer	____	____	____	____
store manager	____	____	____	____
other ________________	____	____	____	____

2. Please indicate, by writing an X in the appropriate blank at the right, which parts of your schooling you consider to be important. Please rank those you marked as "Highly important"; use "1" for the thing you think is most important, "2" for the next most important, and so forth.

	Importance High	Importance Med	Importance Low	Rank those marked High
social studies	____	____	____	____
writing	____	____	____	____
arithmetic skills	____	____	____	____
socialization	____	____	____	____
problem solving	____	____	____	____
technology	____	____	____	____
health	____	____	____	____
driver education	____	____	____	____
physical education	____	____	____	____
spelling	____	____	____	____
speaking	____	____	____	____
science	____	____	____	____
music	____	____	____	____
foreign language	____	____	____	____
art	____	____	____	____
vocational	____	____	____	____
preparation	____	____	____	____
literature	____	____	____	____
business education	____	____	____	____
homemaking	____	____	____	____
industrial arts	____	____	____	____
English grammar	____	____	____	____
lab experiments	____	____	____	____

3. Each of the statements below expresses a feeling toward science or the teaching of science. Please rate each statement on the extent to which you agree. For each you may (A) strongly agree, (B) agree, (C) be undecided or neutral, (D) disagree, or (E) strongly disagree.

A	B	C	D	E
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

1. Science is very interesting to me.

    ___ A ___ B ___ C ___ D ___ E

2. I don't like science, and it scares me to have to take it.

    ___ A ___ B ___ C ___ D ___ E

3. I am always under a terrible strain in science class.

    ___ A ___ B ___ C ___ D ___ E

4. Science is fascinating and fun.

    ___ A ___ B ___ C ___ D ___ E

5. The idea of being a science teacher is not very pleasing.

    ___ A ___ B ___ C ___ D ___ E

6. Science makes me feel secure, and at the same time it is stimulating.

    ___ A ___ B ___ C ___ D ___ E

7. I feel confident that I can teach science to children.

    ___ A ___ B ___ C ___ D ___ E

8. Science should be taught as a way of gathering information rather than as a body of facts.

A B C D E

9. Physical science makes me feel uncomfortable, restless, irritable and impatient.

A B C D E

10. In general, I have a good feeling toward physical science.

A B C D E

11. I think I will enjoy teaching science.

A B C D E

12. When teaching science to children, the facts and concepts of science should be stressed.

A B C D E

13. Being able to carry out science experiments is preferable to knowing many science facts and concepts.

A B C D E

14. When I hear the word science, I have a feeling of dislike.

A B C D E

15. I approach science with a feeling of hesitation.

A B C D E

16. Teaching children how to conduct experiments would be a worthwhile task.

A B C D E

Interview Questions

1. Tell me about some of the things you did in the program that you felt were like teaching.

2. Did you gain insights about what teachers do?

3. Do you believe you will consider becoming a teacher because of the things you did in the program?

4. Tell me about your career choices.

5. What are some things you wish you had an opportunity to do during the program?

6. How might we improve this program?

17. I really like science.

___ A   ___ B   ___ C   ___ D   ___ E

18. I have always enjoyed studying science.

___ A   ___ B   ___ C   ___ D   ___ E

19. It makes me nervous to even think about doing a science experiment.

___ A   ___ B   ___ C   ___ D   ___ E

20. I feel more confident about teaching science than I did a year ago.

___ A   ___ B   ___ C   ___ D   ___ E

21. I feel at ease in science and I like it very much.

___ A   ___ B   ___ C   ___ D   ___ E

22. I feel a definite positive reaction to science; it's enjoyable.

___ A   ___ B   ___ C   ___ D   ___ E

23. I plan to teach children how to gather and analyze their own data.

___ A   ___ B   ___ C   ___ D   ___ E