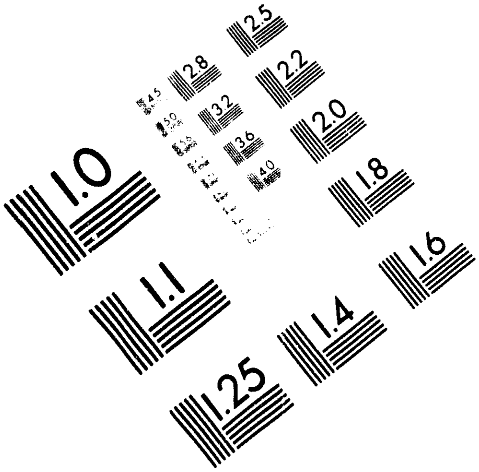

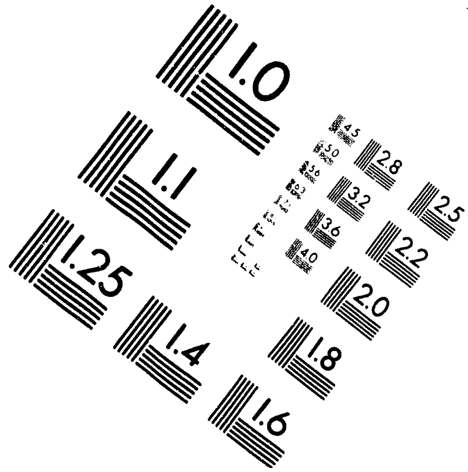

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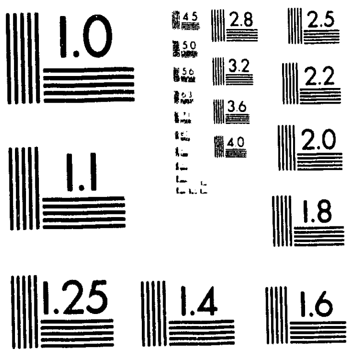

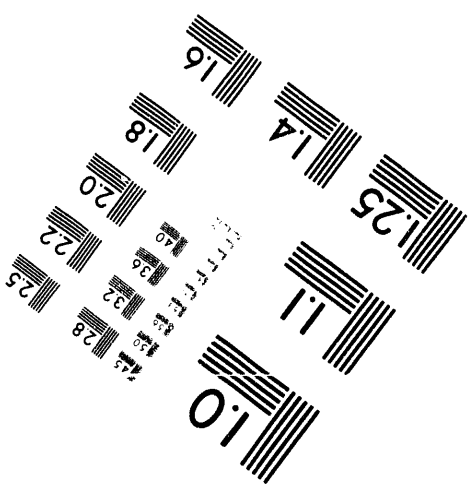

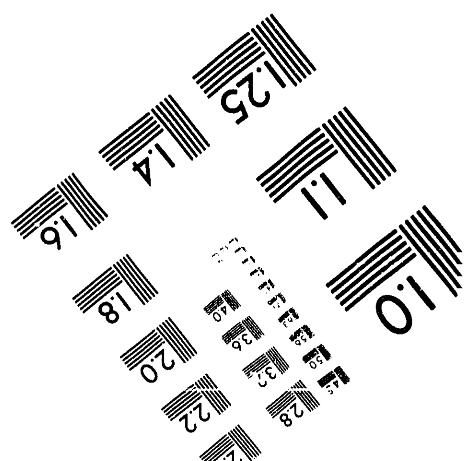

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Emeritus Scientists, Mathematicians and Engineers

A Program of the Emeritus Foundation

THE (ESME) Program

A REPORT

of the Third Year's Activities (1991-92)

"...but the education problem is not a shortage of motivated Americans with good ideas about how to serve our children better: it is a failure to create the necessary institutional capacity, to aggregate enough resources, and-- most important-- to persist with a specific program of reform...."

In the National Interest: The Federal Government in the Reform of K-12 Math and Science Education, A Report of the Carnegie Commission of Science, Technology, and Government (September 1991)

1 September 1992

Report by Harold I. Sharlin
Program Director

Emeritus Scientists, Mathematicians and Engineers (ESME) Program

Summary of Activities for School Year 1991-92

I. Introduction

The Emeritus Scientists, Mathematicians and Engineers (ESME) program matches retired scientists and engineers with wide experience with elementary school children in order to fuel the children's natural curiosity about the world in which they live. The long-range goal is to encourage students to maintain the high level of mathematical and science capability that they exhibit at an early age by introducing them to the fun and excitement of the world of scientific investigation and engineering problem solving.

The components of the ESME program are:

1. emeriti from a wide array of professional and technical backgrounds who have a lifetime of experience using mathematical and scientific tools in satisfying careers. The Program locates, recruits, orients and supports these volunteers.

2. the establishment of teacher-emeriti teams that work to produce a unit of six class hours of demonstration or hands-on experiments characteristic of the work that scientists and engineers perform.

3. the encounter by students with the world of science and engineering through the classroom sessions and a field trip to a nearby plant or laboratory.

II. Recruitment

A. Locating Recruits

All the evidence indicates that the number of retired scientists, mathematicians and engineers in Washington metropolitan area numbers in the thousands. Professional organizations, such as the American Chemical Society, have local affiliates of retired chemists. Corporations such as General Electric and Potomac Electric Power have newsletters and irregular meetings of retired employees. Goddard Space Center, the

National Institute of Standards and Technology, and the National Institutes of Health, among others, have alumni organizations.

During 1991-92, the ESME program enlisted the aid of a number of local professional groups and organizations in locating retired technical and scientific personnel who might be interested in the Program. The following gave much appreciated aid:

1. The National Academy of Sciences: Dr. Frank Press, President of the Academy, wrote a letter to over 200 Academy emeriti in the D.C. area. (see copy of letter attached).

2. The Alumni Association of the National Institutes of Health mailed 280 letters to its members urging those interested to attend a panel discussion of the merits of the ESME program. (see letter attached)

3. The American Society for Cell Biology sent over 250 letters to emeritus members signed by its Executive Director and the Chair of its Education Committee. (see letter attached).

4. Potomac Electric Power Company sent a notice to all of its retired employees and included a notice in its retiree's newsletter, *The Communicator.*

5. The Society of Automotive Engineers (SAE) provided a list of its local

retired members as did the National Institute for Standards and Technology..

6. ESME retirees were an additional valuable source of names because emeriti supplied names and phone numbers of people whom they knew were or might be interested in volunteering.

Another means of locating prospective emeriti is through articles in newspapers or magazines. On 6 February 1992, T*he Washington Post* published a feature article on ESME entitled, "Retired Scientists Go Back to School" in the District Weekly section. A photograph showed an emeritus giving a demonstration of the elasticity of athletic balls to a fifth grade class. The article resulted in a number of comments and phone calls.

SCANNER, the newsletter of the National Capital area Council of the Institute of Electrical and Electronics Engineers, April/May 1992 published a profile of an ESME volunteer, "Howard Heydt: The Non-Retiring Engineer." The journal of the American Society for Engineering Education (ASEE) *PRISM,* published a color photograph of a group of eager elementary school children crowded around a volunteer in an article, "Far From Elementary."

The ESME director was interviewed on three local radio/television programs broadcast by WTOP, WGAY and the Howard University Channel 32.

B. Recruiting

Once a retired scientist, mathematician or engineer is identified through alumni lists, newsletters or other emeriti, the Director follows-up by means of telephone and mail in order to recruit the interested party. A great deal of effort is expended to interest prospective volunteers in becoming involved, and, although no statistics are kept, the number who actually sign on is a small percentage of those contacted.

Recruiting continues throughout the year and an emeriti can start with a class at any time. Approximately thirty volunteers began with ESME in September 1991. The number of volunteers remained constant through the year with new people recruited to replace those who moved out of the area, lost interest, or, more usually, dropped out because of the demands of consulting work. The attrition rate was about 30 percent.

Fifteen of the thirty emeriti actually met with classes. Ten volunteers were not ready to meet with classes feeling, as they did, that they needed more orientation. Ten of the thirty volunteers did not meet with a class because they were unable to establish a working link with their assigned teacher.

C. Orientation

For the first two years of operation, ESME orientation was an informal exchange of experiences by emeriti who had met classes. A volunteer commits to spending six class hours, usually one hour a week over six weeks, with a given class. In this time the emeritus conducts demonstration and/or hands-on experiments of his or her own devising. Emeriti have been remarkably imaginative in devising experiments that relate to the work they performed during their careers. A PEPCO operating engineer brought an opened watt hour meter to class. A microbiologist showed the children bacteria under a surplus government microscope.

Sharing experiences was an excellent method of orientation. A few volunteers ventured beyond their specialization in their classes; for example, a research biochemist gave lessons in scientific measurement. A volunteer's handbook is being developed that will describe some of the more successful efforts. The handbook will be organized according to scientific or engineering category such as chemistry, physics, biochemistry, electrical engineering.

During 1991-92 a former elementary school teacher who had taught in the D.C. system for 23 years was engaged as a consultant to assist with the orientation process. The consultant discussed the behavior of small children, the realm of the teacher and some insights from educational psychology. Because the consultant had no background in science she was most successful in explaining the teacher's role, and as a liaison to the teachers. The engineers/scientists did not find these orientation sessions particularly useful. In the future, the ESME Program intends to try using a consultant with experience in elementary science education.

Some more structured orientation techniques will be tried for those who need more help in bridging the gap between working with professionals and designing experiments for ten year olds.

D. Materials

Equipment for classroom experiments is directly related to orientation. The availability or unavailability of certain materials will dictate what can be done. Without a microscope the microbiologist was limited to a description of bacteria. On the other hand, an electrical engineer discovered a model generator by chance and made that a part of his unit demonstrations.

In 1991-92 considerable progress was made by ESME in supplying emeriti with materials they needed. A GE three year grant for supplying and replenishing a "laboratory" at Bunker Hill Elementary School allowed the Program to acquire much needed materials. A committee composed of three emeriti from different disciplines, the school's science coordinator and the principal drew up a list of materials and science kits needed for use by emeriti working in Bunker Hill. After many unavoidable delays, the "laboratory" was dedicated at the end of the school year.

The ESME Program will use the experience with this first laboratory for establishing other sites in schools where it operates. Volunteers have proposed that a locked closet be used to serve as a storeroom for materials so that they will not have to be transported.

Some emeriti have made permanent acquisitions such as a carousel slide projector and a beaded screen for their work. Others have purchased consumable materials such as chemicals. Funding was available for reimbursing all these purchases.

Several alternatives will be tried for supplying the equipment that emeriti need on site. One suggestion is to have a central location such as the ESME office for distribution that might be done by messenger service. Expenditures for supplies and equipment will bring a large return through the more effective use of volunteers' time.

III. The Teacher-Emeritus Team

Teacher-emeritus teams are formed by the teacher selecting the person she or he wants to work with. Profiles--one page resumes-- of each emeritus are distributed before an emeritus-teacher meeting. Teachers choose the emeritus they wish to work with usually based on science areas that the teacher wants to know more about. By leaving the selection process in the teacher's hands the ESME Program maintains its voluntary aspect. Teachers elect to be in the program and they choose their partners.

The ESME program success rests firmly on the teacher-emeriti relationship. At the outset of the Program both teachers and volunteers are asked specifically to work as a team. The classroom is the teacher's realm and during emeriti sessions he or she is completely responsible for discipline. The teachers participate in the science activities partially to give much needed assistance and mostly to demonstrate to the children that the activity is an important part of class work. Some teachers require their students to write short reports of what the scientist/engineer did during the hour.

The teacher is crucial in preparing the volunteer for the particular class. Advice by the teacher as to the level of understanding of her or his class enables the volunteer to gauge the difficulty of the presentation. Since every class is different, every time a volunteer begins a new class the teacher must brief him or her on what can and cannot be done with this class. Schools within and outside of the District vary widely in the cultural setting as well as the capability of the children. Cook Elementary in downtown Washington has some of the least privileged children in the area whereas Bunker Hill Elementary near Catholic University for instance, has a much more middle-class student body.
The teachers in the schools are the people who know their students the best.

The teacher's role includes integrating the emeritus' work into the classroom. Prior to the first class of the emeritus unit, the teacher and volunteer meet to coordinate. At that time the emeritus will propose experiments and the teacher can either aid in adapting them to this particular class or suggest that the planned activity is too difficult for her class. There usually are two hours of these preliminary meetings during which the schedule of visits is arranged so both the teacher and the emeritus can fix their schedules accordingly.. Home telephone numbers are exchanged so that the other party can be informed of any change in the schedule.

Since elementary school teachers are not generally experts in science, the emeritus can enhance the teacher's overall knowledge and science competence as the joint effort goes forward. ESME does not teach the curriculum, but volunteers find their work supplements the science requirements very nicely.

The teacher prepares her class for the emeritus visits by telling the class what is planned and she introduces the emeritus by telling the class something of the scientist's/engineer's background. If the vocabulary to be used in the science experiments is unfamiliar to the children, the emeritus will send the teacher a list of vocabulary words and she can review them in advance with the class.

The enhancement of the teacher's science- based knowledge grows through a non-threatening relationship with the emeritus partner. During 1991-92 one successful device for enhancement occurred by chance. The science coordinator at Cook Elementary school saw an emeritus microbiologist performing a simple demonstration of the reduction of bacteria on a child's hands by washing the child's hands. The science coordinator asked the microbiologist to demonstrate the experiment for the other teachers at the school. These demonstrations of simple experiments will continue as a planned part of the ESME program. A recent National Science Foundation grant will provide funding for summer institutes, with emeriti serving as mentors for teachers.

IV The Students' Encounter with Science and Engineering

Class sizes varied from 18 to 30 children. An estimated 730 children had an experience with a scientist/engineer during the 1991-92 school year. Fifteen percent of these students were in kindergarten through third grade and 79 percent were in fourth through sixth grade. The remaining 6 percent were junior high students.

None of the emeritus volunteers had experience teaching grade school before coming to the program. The emeriti design their own simple experiments that illustrate some basic ideas in science or engineering. Imagination is the key in designing experiments and one must be impressed with the creative effort exhibited by the volunteers who have been dealing with adults all of their professional life.

For example, one class was asked what floats and what doesn't? Why? The class was given simple objects--bottle, paper clip, plastic material and sail boat-- to see for themselves. This easily performed experiment introduced second graders to the basic Archimedean principle. A fifth grade class tested different foods to determine if they were protein, carbohydrate or fat.

All classes learn about the differences between an engineer and a scientist through the emeritus talking about her or his career. What each did during his or her professional career is a picture off the page for the students.

Light, energy, what causes lift in a heavier than air craft--all of these principles are explained in easily understood terms. The teachers are the guides at all times as to what the students will understand or what is beyond them. Several times the emeriti were told that some of the scientific principles were above the students' heads. But an occasional bout of mind stretching is good, one teacher remarked, especially for sixth graders who think they already know everything. Volunteers describe to their teachers what they hope to do, usually giving the teacher an outline of the subjects to be covered as well as a vocabulary.

A catalog of all subjects covered would be too long for this report. When the volunteers' handbook, now in process, is completed it will contain summaries of the most successful experiments and at what grade level they were performed. In addition each description will have the name and phone number of the experiment's designer. Emeriti freely exchange information at our meetings, A cleverly designed experiment will suggest other ways of reaching the children.

Field Trips

The starting point for the ESME program was to motivate school children to consider careers in science and engineering. Field trips were an integral part of the program because seeing where scientists and engineers work is an ideal way to show children what the work is like.

The emeritus arranges for a trip at the end of the six session unit. The location is arranged for by the scientist/engineer. The teacher manages all the logistics including permission slips and the like. The funding for the program enables ESME to pay for buses.

Field trips during 1991-92 were to such places as:

1. NIH Clinical Center, where children visited a research laboratory and saw an electron microscope.

2. National Zoo animal facility.

3. Wind tunnel at the University of Maryland- children walked through the tunnel.

4. Goddard Space Center, guided tour of satellite preparation center.

5. Holographic Museum. (Admission charged.) Tour with explanation of holography.

6. Benning Road incinerator to see first hand about problems of waste disposal.

7. National Museum of American History

8. Earth Observation Satellite Company in Lanham, MD.

9. Earth Satellite Corporation in Rockville, MD.

10. National Air and Space Museum

11. Sidewalk outside of school for a examination of "urban geology."

12. International Aerospace Exhibit

13. PEPCO's Chalk Point Generating Station- students saw how coal is turned into electricity.

The field trips widen the students' world both physically and psychologically.

Volunteer Recognition

On 9 April 1992, the Emeritus Foundation held its first Annual Awards Ceremony at The Sumner School. Mayor Kelly gave the keynote address, "Volunteering for the District of Columbia." Thirty-four Emeritus Scientists and Engineers received certificates of appreciation and a bronze pin. Dr. William Condell received the Roy T. Osborne community Service Award. Mr. Osborne, who died recently was an early and enthusiastic volunteer.

Emeriti receive no compensation for their time and often they used their own money for supplies and equipment before program funding was available. It was estimated that emeriti contributed over 420 hours of their time during the l991-92 school year..

Funding

Funding for the ESME program during the school year, 1991-92, came from:

Cafritz Foundation

Hattie Strong Foundation

C & P Telephone

Department of Energy

Armed Forces Communications and Electronics Association

General Electric Foundation

Chevron

Washington Post

Boeing Corporation

Rockwell International

Conclusion

The Emeritus Scientists, Mathematicians and Engineers (ESME) program has grown and progressed in the three years that it has been operating. The program now rents an office with a conference room available for emeriti meetings. The program director , as of 1 August 1992, has a part-time assistant/secretary.

The number of volunteers has increased from six in 1989 to an expected cadre in 1992-93 of between 40 and 50 people. The program began in 1989 with two schools and in 1992 will have eight schoois including two new schools, Greenwood Elementary and Westbrook Elementary, in Montgomery County.

The increase in size is a small measure of the acceptance that the program has received both from the professional community and from the school system.

The goal of the ESME program has been to establish a free standing organization independent of the school system but integrated into the school program. The aim has been to provide both personnel and material resources so as not to be a burden on or dependent on the school system. With the awarding of a three year grant from the National Science Foundation the financial independence seems attainable.

The next year will emphasize preparing and providing for the needs of the emeriti. The volunteers have been extraordinary in the creative way they have prepared experiments. The program wants to build on that creative framework and establish a system of experiments and materials that will serve a growing number of scientists and engineers.

EMERITUS SCIENTISTS, MATHEMATICIANS & ENGINEERS (ESME) PROGRAM

EVALUATION REPORT

SY 1991–1992

Harold I. Sharlin, Ph.D.
ESME Program Director

DISTRICT OF COLUMBIA PUBLIC SCHOOLS

EMERITUS SCIENTISTS, MATHEMATICIANS AND ENGINEERS PROGRAM

FINAL EVALUATIO" REPORT

THE EMERITUS FOUNDATION

ESME PROGRAM

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October, 1992

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EXECUTIVE SUMMARY

Program Overview

The Emeritus Scientists, Mathematicians, and Engineers (ESME) program is achieving considerable success in its efforts to generate a higher degree of "scientific literacy" among students in the District of Columbia Public Schools. Findings generated from the 1991-1992 ESME program evaluation provide direct evidence of heightened student interest in a variety of scientific and technical fields. With impetus from the initial success, the program is intensifying efforts to accomplish its long-range goal of keeping students studying mathematics and science at more advanced levels with the hope that, ultimately, higher levels of skill development achieved will translate into career choices in mathematics, science and engineering.

The genesis of the ESME program dates back to 1988 when the Emeritus Foundation (EF), a Washington-based, non-profit organization, took the initiative to bring retired scientists and engineers into classrooms in the District of Columbia Public Schools (DCPS) to introduce students to a range of career opportunities in the scientific and engineering fields. This effort is one response to the concern that public school students in the District of Columbia do not live up to early indications of scientific and mathematical talent in terms of career choices in advanced mathematics and science related fields.

Current statistics, according to national research data, indicate that third grade students in the DCPS perform well above average -- scoring at the 60th and 64th percentile in mathematics and science, respectively. This trend continues up to sixth grade, after which time a pattern of decline ensues. The long-term consequences of this decline in student achievement is evident in the prevailing career trend which shows that students in the DCPS do not, as a rule, follow career paths in science or mathematics.

The ESME program takes the view that efforts to reverse this trend must continue to be energized, particularly because so much is dependent on the ability of this generation of students to produce and manage the technology necessary for the nation to remain competitive. Recent projections indicate that by the 21st Century an estimated 70% of the more competitive jobs will require a higher level of science and mathematics proficiency than is currently the case.

Research in developmental psychology shows that science and mathematics learning in young children is strongly linked to sense perceptions and children move toward an understanding of the more abstract concepts only after they have first experienced the ideas on a concrete level. As a first step in steering students toward career choices in science and engineering, the ESME program introduces students (starting as early as kindergarten age level) to the wonders and excitement of science through a whole range of concrete experiences.

Simple classroom experiments simulating the real world of scientists and engineers are conducted in portable, make-shift laboratories. Students make direct contact with the tools of working scientists. They weigh objects, estimate measures, try out experiments and execute problem solving activities. Additionally, students get to know the individual scientist or engineer. They learn, firsthand, about his or her field of specialty when they visit the facility where the actual work is being done.

Fourth grade students, for instance, get a more comprehensive understanding of how electricity is generated when an electrical engineer uses magnets and wires to illustrate the process, and then takes the students to an electric and power generating station. Similarly, a nuclear physicist shows his sixth grade students how to read x-rays, and then takes the class to the nuclear medicine facility of a local hospital to experience, firsthand, how an actual x-ray is executed. An aeronautic engineer suspends paper planes built by fifth graders in a make-shift wind tunnel, and then takes the class to the Goddard Space Center.

In effect, the instruction process engages the students in science and engineering activities that provide for concrete and direct applications to the everyday world. Gradually, students begin to develop an appreciation for the connection between the material learned in the classrooms and its practical application in the real world of working scientists and technologists.

These pedagogical strategies employed by the ESME scientists are quite propitious in terms of the newly revised goals for the school dictrict's math/science curriculum. The new thrust in mathematics and science focuses on: the integration of hands-on participatory learning in which students are encouraged to explore, develop, test, discuss and apply ideas; the demonstration of the inherent interrelationship of science, mathematics and technology so as to facilitate the transfer of skills in these subject areas to real-world situations (Washington DC2000, 1992, p. 16).* Given that the ESME program is already on stream, the program is well poised as an excellent reference source from which workable strategies can be drawn to facilitate integration of hands-on participatory student learning.

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*Washington DC2000, "Building Learning Communities: A Framework for Preparing Students for the 21st Century" (District of Columbia Public Schools' Response to America 2000), June, (1992).

During its three-year operational period, the ESME program has grown in size and scope. In its first year, seven volunteer professionals with long, distinguished careers in the scientific and engineering fields worked with students from fourth grade through sixth grade in two schools. At present, a cadre of thirty such volunteers serves over seven hundred students -- kindergarten through junior high -- in six schools.

Evaluation Procedure and Objectives

Basic Model

The ESME program evaluation followed a three-step model of input-process-outcome. Within the framework of the three steps, the evaluation findings summarize the effectiveness of the program from a number of perspectives. At the input level, the features of major ESME program components are identified. The process level emphasizes some specific attributes of the general program operation and instructional delivery management. At the outcome level, indicators of attitude and achievement factors are articulated. A range of qualitative information gained from the perspectives of the emeriti, classroom teachers, students and parents defines and describes both tangible and intangible aspects of the program outcomes.

Objectives

The evaluation was guided by the following four major objectives:

1. To identify those ESME program components and characteristics that make it possible to execute the program in the targeted schools. (Input)

2. To identify elements pertaining to the general program operations and the instructional delivery management which, together, make the ESME program work effectively. (Process)

3. To ascertain indicators of the extent to which the ESME program is developing favorable student attitude toward (a) the learning of mathematics, science and engineering and/or, (b) career choices in mathematics/science related fields, i.e., indicators of the degree to which students are thinking about following career paths in mathematics, science and engineering. (Attitudinal Outcome)

4. To generate indicators of the overall achievement profile in mathematics and/or science of the students participating in the program. (Achievement Outcome)

Highlights of the Findings

Objective 1: Program Components

The findings summarized for this objective indicate ways in which major program components facilitate the successful implementation of the ESME program in the target schools. Five components and their characteristic features are outlined as follows:

- The ESME Program Director actively recruits volunteers (retired as well as working scientists) to work with students in classrooms at the local school sites. These scientists come to the program with a wide range of expertise in fields such as physics, chemistry, biology, geology and engineering. Based on these credentials and the scientists' choice of school and age level of students, scientists team up with participating teachers to prepare students.

- The ESME program, in collaboration with D.C. school personnel, provides orientation to help the emeriti adapt to the classroom setting. Scientists and teachers together plan procedural strategies to help simplify some of the more hard-to-grasp concepts so as to ensure that the subject content, style and mode of presentation of the material are compatible with the cognitive developmental level of students. For many emeriti, making the transition from years of experience with adults in the professional world to younger children in the classroom setting was, reportedly, quite challenging. Gradually, the scientists report, the actual interaction with the students was very helpful in establishing speedy rapport between youth and experience in the classrooms.

- Each emeritus volunteer works with students at the local school level in at least one work cycle. One work cycle is represented as six class hours, over a six-week period. A more comprehensive breakdown of the time-task schedule of service provided by the volunteer scientists/engineers for the school year ending 1992 is as follows:

    Of the cadre of 30 scientists/engineers a total of 15 worked directly with children in the classroom. An additional 10 did not participate in actual classroom teaching because they felt they were not adequately prepared. The remaining five did not establish contact due one of two reasons: either the classroom teacher failed to carry out procedural steps to facilitate the service or the emeritus was unable to meet class due to the urgency of other business.

    Emeriti met with a total of 20 classes (class size approximately 30) for six or more hours in six schools.

This means that some 600 students were served by the ESME program for the school year.

The total emeriti volunteer time contribution was 420 hours, of which, 360 were spent in lesson preparation and in classroom contact with students. Time spent on field trips and on judging science fairs accounted for the remaining 60 hours.

o To secure resources for the effective implementation of the program, the ESME Program Director raises money from a variety of well known local organizations. Funds have already been approved by one such organization to construct a science laboratory in an elementary school in one of the northeast neighborhoods of the District. Funds raised also help to provide equipment. Yet, existing resources are still limited. In many instances, however, the scientists come to the classrooms well equipped with impressive, portable, micro laboratories and their own tools and make-shift devices. It has been reported by scientists and teachers alike that instructional materials to facilitate full student participation in hands-on experiments and other classroom activities are quite inadequate.

o The ESME program recognizes the emeriti for distinguished community service. In collaboration with representatives of the D.C. Government and officials of the DCPS, the Emeritus Foundation sponsors annual awards presentations to honor emeritus scientists, teachers and social workers. The full complement of ESME scientists received awards and/or certificates for outstanding service at the April, 1992 honors ceremony.

Objective 2: Program Operations/Instructional Delivery Management

To meet the second evaluation objective which calls for the identification of ways in which specific ESME program operational procedures and instructional delivery management contribute to the achievement of the overall program success, five central points are summarized as follows:

o The program focuses on preparing students at the elementary level. Fifteen percent (15%) of the participating students are at the kindergarten through third grade level, while 79% are fourth through sixth graders. Current research supports the premise that early exposure to mathematics/science is important to the achievement of the ultimate goal of stimulating sustained student interest in the sciences.

o Each emeritus volunteer works with students in classes, with sizes varying from about eighteen to thirty students, for six weeks. Some volunteers do more than one six-week cycle. Indeed, a number of them put in as many as 4 work cycles (24 hours) for the school year.

o Emeriti report that low levels of language/reading proficiency among a number of students need to be significantly improved in tandem with the ESME program so that greater progress in concept analysis activities for more students can be achieved.

o At least four "standard" models were used in the instructional delivery process: lecture demonstration, general discussion, hands-on experiments and problem solving/concept analysis.

o Instructional approaches successfully integrated classroom simulations of the operations of scientist or engineer with operations of the real world. For example, fifth grade students were learning Newtonian physics on the laws of motion and relating the principles of these laws to simple everyday experiences. Third grade students observed a number of experiments set up in make-shift laboratories demonstrating ways in which force/pressure operates in conjunction with other variables to (a) create weather conditions such as a small-scale thunder storm and, (b) launch a rocket.

Objective 3: Indicators of Heightened Student Interest

As predicted, overwhelmingly, students enjoy the ESME program activities and spend more time learning mathematics and science. Indicators of the overall student attitude toward the science program are summarized in the following:

o Eighty percent (80%) of the students reported that they enjoy their classes with the scientists, and 57% of them indicated that they are now spending more time doing mathematics and science.

o Eighty-seven percent (87%) agree that they are learning new and exciting things in the ESME program classes.

o Sixty-nine percent (69%) of the teachers questioned estimated that over 50% of their students are demonstrating a more positive attitude toward mathematics and science learning.

o Parents often participate by purchasing materials and helping their children try out some of the experiments conducted in class. The results of these "home-based tryouts" are usually shared in class with other students.

o A large majority (66%) of the students taught by emeriti scientists and engineers report that they are more interested in the ESME science classes than they are in their regular classes.

o The responses of students, indicating greater interest in mathematics compared to regular classes, were disappointingly low. One explanation for this outcome is that mathematics is not offered by the ESME program in the formal sense but, rather, is introduced to students as a technical tool to explain certain principles in the sciences.

o A significant proportion (76%) of the students reported that they are getting a better understanding of science and engineering ideas as a result of their participation in the ESME program.

o Sixty-one percent (61%) have developed greater confidence in their ability to do well in mathematics and science. This level of confidence may be related, in part, to the increased level of understanding of the subject matter students are experiencing.

o Indicators of the degree to which students are thinking about **following career paths in mathematics, science and engineering** are modest. Approximately thirty-six percent of the students have decided, so far, that they want to become mathematicians, scientists and engineers. Although this 36% is described as modest in absolute terms, yet, the percentage is quite large when measured against the very small percentage in the larger public school student population who pursue mathematics- and science-related careers. Indeed, the achievement of a 36% rate over the long run, for students who actually follow-up on their early interests to pursue careers in the respective science disciplines, would be regarded as a very impressive index of success.

Objective 4: Achievement Outcomes

Students' overall achievement profile in science and mathematics for a sample of the ESME students provide some indicators which appear to confirm our expectation that although the emeritus scientists do not teach the standard curriculum prescribed for the school system, the heightened stimulation in the sciences that students experience through the ESME program would help promote achievement in mathematics and/or science at a level higher than would have been prcbable without the program. For example, national norm-referenced data for the 1990-1991 and 1991-1992 school years reveal evidence of a systematic relationship between the ESME program intervention and accelerated student achievement. It is important to note, however, that the absence of pretest scores in some instances limited the ability of the analyses to control for the margins of initial group differences that might have been present at the pretest stage. Hence, caution is advised regarding the degree of the relationship reported.

- o In the school year ending 1991, that is, during the second year of the program, ESME students made some impressive NCE gains in mathematics concepts and applications (CA) scores over an equivalent group of students who were not served by the program (i.e., a control group). When the mathematics CA test scores of 24 fourth grade ESME students were matched with the scores of an equivalent sample of 21 control students, there was a statistically significant average gain of 16.4 NCE.* The ESME group mean (average) score was 80.3 NCE or the 92nd percentile while, the control group mean was 63.9 NCE or the 74th percentile.

- o A comparative analysis of the test results for the same two groups of students showed a similar accelerated achievement trend in science. ESME students made gains of approximately 8 NCE over the gain shown in the control group. The actual scores were 73.9 and 66.1 NCEs for ESME and control groups, respectively. The matching percentile (%ile) score equivalents are 87 for the ESME and 77 for the control students.

- o The achievement trend continued among fourth graders at a second elementary school except in this case the group means were generally lower. Analysis of the science and mathematicsdata for 35 ESME and 37 control students for the 1990-1991 school year indicated the following NCEs and %iles:

  For mathematics concepts and application skills ESME group mean was 62.7 NCE (73 %ile) and the control group was 49.4 NCE (48 %ile); so that the actual mean difference is an impressive 13.3 NCE.

  In science, the means were 57.2 and 46.3 NCE and 63 and 48 %iles for the ESME and control groups, respectively. The actual mean difference is a significant 11 NCE (approximately) and 15 %ile points.

- o The 1992 NCE science and mathematics test data for sixth graders in two additional elementary school taken together indicated that the ESME students made both strong and marginal increases over the performance of the control group of 26

*NCEs are Normal Curve Equivalent scores ranging from 1 at the base to 99 at the ceiling and are used as indicators of students' national norm-referenced performance levels within and across subject areas.

students as follows:

For the ESME group, the mean increase in science skills over the mean for the control group was 9.4 NCE. The ESME group scored 67.3 NCE (79th %ile) and the control group 57.9 NCE (64th %ile).

In mathematics, the mean difference for these sixth graders was shown to be 4.0 NCE; with the ESME group scoring 70 NCE at the 83rd %ile and the control group scoring 66 NCE at the 77th %ile.

o The mathematics test data for school years ending 1991 and 1992 for 29 fifth and sixth graders in a fifth elementary school also revealed a trend in achievement gains. Mathematics concepts and applications scores grew from 40.1 NCE or 32nd %ile in 1991 to 43.8 NCE or 39th %ile in 1992 -- an increase of, approximately, 4 NCE or 7 %ile points. It is important to note that the low scores reported should be viewed against the background that the school which these students attend is located in an area where a large percentage of the student population qualify as socially disadvantaged and the students' academic needs are often a great deal more severe than those of their more privileged counterparts. The results must, therefore, be viewed in the positive light of the sizeable achievement growth trend demonstrated.

o A high correlation was shown between students' level of reading skills and their mathematics and science proficiency. This finding underscores one important observation made by the scientists which states that during their tenure of instruction with the students they were able to achieve greater progress in concept analysis activities in instances where students had higher levels of language/ reading proficiency.

Other Evaluation Observations

o Teachers have noted positive, incremental changes in students' behavior that are attributed to ESME program effects. These include greater interest in science and technology in and out of the classroom as well as for a future career. Teachers report also that students are now demonstrating greater responsiveness to analytical tasks.

o In some instances, emeriti request further assistance in instructional techniques to improve their effectiveness in the classroom. One-third of the 15 emeriti who responded to the questionnaire indicated that they needed additional help in devising teaching methods and hands-on experiments.

o Volunteers suggest that better organization of field trips, more contact with teachers as well as more hands-on training for younger students would improve program efforts.

o Teachers and ESME volunteers see the strengths of the program in the enriching interaction between students and scientists/technologists as well as the broadening of career horizons of the students.

o Emeriti and teachers together view the program as very motivational to students.

Summary

The evaluation concludes that the ESME program is beginning to achieve its goal of motivating greater student interest in the learning of mathematics and science. At present, some 730 students in public schools in the District of Columbia are being introduced to a range of scientific and engineering expertise in fields such as physics, chemistry, biology, geology and engineering. With the potential for significant growth in the number of students involved in the program, there is an obvious need for additional equipment and instructional material to enable greater student participation.

In the teaching process, scientists combine direct instruction in higher-order skills with activities that encourage students to (1) think profoundly about concepts, and (2) explore mathematical formulas as analytical tools in the application of these concepts. The net effect is that students are developing greater interest and achievement in the sciences and are enjoying the challenges in problem-solving and hierarchical concept analysis. With impetus from this initial success, the program is well poised to achieve its long-range objective of keeping students studying mathematics/science at more advanced levels and, ultimately, steering them towards career paths in the science and technical fields.

Recommendations

o With the ESME program now exposing students to a wide range of career possibilities in mathematics and science, there is an immediate need to establish an information dissemination system to answer students' inquiries on what concrete steps are necessary to become a scientist or an engineer.

o Given the achievement of heightened student readiness for greater learning in the sciences, the ESME program is uniquely poised to broaden and enrich the scope of student preparation for successful science and engineering careers. The program could further energize and expand student progress in problem solving and higher-order concept analysis in a number of ways.

For example, the science laboratory installed at Bunker Hill Elementary, should operate as the hub for generating and sharing a number of the ESME science and engineering projects and creative ideas that are now being generated in individual classrooms. By this means, the excitement and challenge of engaging classroom discourse that often take place between scientists and students will embrace a wider group of ESME program participants.

In the meantime, emeriti should work to help teachers with the development of laboratory-based projects so that teachers may be able to continue the more practical approach to the teaching of science initiated by the scientists.

o Drawing from their experiences with the ESME program, the scientists are well poised as a unique reference source to assist the school system in its quest for workable practical strategies that will demonstrate to students the inherent interrelationship of science, mathematics and technology so as to facilitate the transfer of skills in these subject areas to real-world situations. Hence, scientists should stand ready to assist in this regard.

o Adequate resources are needed to allow for the expansion of the program, the participation of more ESME volunteers and the provision of additional equipment to facilitate full student involvement in practical classroom activities.

o More comprehensive instructional delivery assistance should be provided to emeriti who need help to improve their effectiveness in the classroom.

o It is important to maintain a format of the present ESME program policy in which the emeriti continue to teach skills related to the respective discipline without being restricted the format of the prescribed DCPS curriculum.

o Efforts should be made to ensure that the students continue to have fun with the activities.

o A parent component should be formally incorporated into the ESME program to provide external reinforcement for classroom activities.

EVALUATION METHODOLOGY

Framework

In keeping with the input-process-outcome model and the four objectives articulated, the evaluation report addresses **four central questions:**

1. To what extent do the identified components/ characteristics of the ESME program facilitate its implementation in the targeted schools?

2. In what ways do the program operational procedures and instructional delivery management, together, make the ESME program more effective?

3. To what extent is the ESME program achieving its stated goal of (a) stimulating increased student interest in the learning of mathematics, science and engineering and, (b) developing favorable student attitudes toward career choices in mathematics/science and related disciplines?

4. Are the students participating in the program making progress in mathematics or science at a level higher than what would have been probable without the program?

Instruments

A total of five instruments were used in the evaluation. They are as follows:

1. **A twenty-item emeritus volunteer/teacher questionnaire** -- soliciting information on ESME program operations, on the instructional delivery management of the program and student attitude/achievement;

2. **One student questionnaire** -- soliciting responses on attitude and achievement variables;

3. **One parent survey** -- soliciting information about parents' role in, and attitude toward the ESME program in general;

4. **Comprehensive Tests of Basic Skills** (CTBS) -- providing indices of student achievement profile on norm-referenced measures primarily in mathematics and science: (the CTBS instrument is administered in DCPS annually, and

5. **Structured interviews** -- focusing on obtaining from emeritus volunteers and teachers their overall perception of the ESME program operations and outcomes.

Sample

The evaluation report is based primarily on information data generated from the 219 students, 15 emeriti and 13 teachers who responded to the questionnaires. These numbers are representative of the total population. Questionnaires were sent to 370 of approximately 730 students that the ESME program now serves. The selection was stratified across grade levels and was representative of the frequency distribution across the one junior high and five elementary schools.

Data Collection Procedure

Evaluation data were collected during the Spring of 1992 from three primary sources namely, (1) Questionnaires: sent to emeriti, classroom teachers and a sample of students and parents, (2) program site observations and interviews of teachers and emeriti and, (3) the DCPS Standardized Testing and Measurement program.

Data Analysis

Several statistical procedures were applied to the data generated to meet the four stated evaluation objectives. These procedures facilitated descriptive, interpretive and inductive analyses. Frequencies and crosstabulations generated descriptive information. To facilitate interpretive information, a two-sample t test statistical technique has been selected to determine whether the students participating in the ESME program performed significantly better on achievement measures in science and mathematics than an equivalent sample of students not in the program.

EVALUATION RESULTS AND DISCUSSION

Findings

Salient evaluation findings are summarized within the framework of the four stated evaluation objectives:

Objective 1: ESME Program Components/Characteristics

In answering the first evaluation question addressing the issue of how major program components facilitate the successful implementation of the ESME program in the target schools, five components and their characteristic features are outlined as follows:

Recruitment

The ESME Program Director actively recruits volunteers to work with students in the classrooms at the local school sites. These volunteers, for the most part, are retirees from a variety of professional organizations. Although the program targets retired professionals, a number of working scientists also participate in the program upon request.

The recruits come, collectively, with a history of impressive professional experience spanning a wide range of disciplines in the scientific and technical fields including: Director of Physics at the Office of Naval Research, research scientist at the National Institutes of Health (NIH), operations engineer for PEPCO, electrical engineer and marine pilot, chemical engineer who once assisted NASA on rocket propulsion, aeronautical engineer in government and private industry, instructors in engineering and the history of science and technology at state universities, geologist with the US government; agricultural researcher with the USDA Agricultural Research Service and physician with the U.S. Navy.

Upon recruitment, scientists, mathematicians and engineers submit credentials detailing their areas of expertise to the Program Director. They meet, subsequently, with the Program Director to work out important logistics such as choice of school and the age level of students. This process ensures that the best possible matching between volunteers and students is achieved.

Orientation

The ESME program receives the enthusiastic support of the District of Columbia Public School System, from the Superintendent and school principals to classroom teachers. The program director collaborates with school personnel to help the emeritus scientists adapt to the classroom setting. Despite formidable achievements of these emeriti and all their years of experience as professional scientists and engineers, making the transition to the classroom for many of them was, reportedly, quite unsettling and even intimidating.

Orientation programs conducted with the Program Director and a program liaison officer as well as with the teachers at the school site helped the emeriti overcome their initial fears and make speedy adjustments. Some volunteers report that the actual involvement with the students provided them with the most meaningful orientation, in that the interaction was very instrumental in helping them enjoy the experience and establish speedy rapport between youth and experience in the classroom.

In the orientation, process volunteers also team up with teachers in at least one two-hour session before the start of the instructional program to discuss the relevant subject matter the scientists plan to present to the students. Teachers and scientists work out procedural strategies to help simplify some of the more hard-to-grasp concepts, thus ensuring that (1) subject content is appropriately suited to the developmental level of the students and (2) the style and mode of presentation of the material are compatible with the cognitive level of students.

One example which illustrates the nature of this team approach to the orientation process is as follows: Scientists prepare the vocabulary or generic jargon to be used in a science lesson. This vocabulary is given to the classroom teacher in advance. The teacher, in turn, takes the students through a "science readiness" program to prepare them to efficiently assimilate the material to be presented by the scientist. First, the teacher gives students some background about the scientist and about the science topic earmarked for presentation. Then, he or she helps students become more familiar with the meaning of the words and their semantic usage in a mathematics/science context. In some instances, teachers will provide students with needed materials or literature ahead of time.

On-going needs assessment is carried out at the classroom level by the program liaison school officer. Methods on how best those needs can be adequately met are worked out and presented, periodically, by the program's liaison officer to the appropriate teachers and/or scientists.

Work Cycle and Time/Task Schedule

Each emeritus volunteer works with students in classes, sizes varying from about eighteen to thirty, in six week cycles. A work cycle is represented as at least six class hours, over a six-week period. Some volunteers often work two cycles (one per semester) for the school year while others work simultaneously with two classes on separate school sites, i.e., both in a single work cycle. Still others put in as many as 4 work cycles (24 hours) for the school year. A more comprehensive breakdown of the time-task schedule of service provided by the volunteer scientists/engineers for the school year ending 1992 is as follows:

> Of the 30 scientists/engineers involved, a total of 15 worked directly with children in the classroom. An additional 10 did not participate in actual classroom teaching because they felt they were not adequately prepared. The remaining five did not establish contact due to one of two reasons: either the classroom teacher failed to carry out procedural steps to facilitate the service or the emeritus was unable to meet class due to the urgency of other business.
>
> Emeriti met with a total of 20 classes for six or more hours in six schools. This means that some 600 students were served by the ESME program for the school year.
>
> The total emeriti volunteer time contribution was 420 hours, of which, 360 were spent in lesson preparation and in classroom contact with students. Time spent on field trips and on judging science fairs accounted for the remaining 60 hours.

The structure of the program is loose in design -- a feature devised to facilitate flexibility for the volunteer scientists. The intent is to keep the work less demanding so as to give the scientists more time to prepare their experiments and build science lessons that are directly relevant to everyday life.

Program Resources and Sources of Support

The ESME Program Director raises money from a variety of well known local organizations to augment existing resources for the effective implementation of the program. Funds have already been approved by one such organization for the construction of a science laboratory at an elementary school site in one of the northeast neighborhoods of the District. Funds raised help, also, to defray ESME program field trip expenses and to purchase equipment to supplement the schools' sometimes very limited supplies. In many instances, however, the scientists come to the classrooms well equipped with impressive, portable, micro laboratories and their own tools and make-shift devices.

Recognition for Service

The ESME program gives recognition to the emeriti for their contribution. The Emeritus foundation, in collaboration with the representatives of the D.C. Government and officials of the DCPS, sponsor annual awards presentations to honor individuals for outstanding community service. The full complement of scientists received awards and certificates for distinguished service at the April, 1992 honors ceremony.

Objective 2: Program Operations and Instruction Delivery

The second evaluation question calls for the identification of ways in which the ESME program's operational procedures and instructional models used contribute to the achievement of the overall program success.

To answer this question, five important points are summarized as follows:

- The program focuses on preparing students at the elementary level. Fifteen (15) percent of the students are in kindergarden through third grade and seventy-nine (79) percent are fourth through sixth graders. The remaining six (6) percent are at the junior high school level. The ESME program operates on the research premise that early exposure to mathematics, science and engineering is of primary importance to the achievement of the ultimate goal of stimulating sustained student interest in the sciences.

- With autonomy in the instructional process, the scientists work with students through instructional delivery models of their own choice. At least four standard models have been used singly and in combination. These are lecture-demonstration, general discussion, hands-on experiments and problem solving/concept analysis. See Table 1 and Figure 1.

- On-site observation in a sample of classrooms generated measures indicating that the instruction process was very effective. Instructional approaches successfully integrate classroom simulations of the operations of scientist or engineer with operations of the real world. Strategies of problem-solving and concept analysis germane to the respective science disciplines were executed in accordance with the nature and difficulty of the subject matter taught.

  In one class, for instance, fifth grade students were learning Newtonian physics on the laws of motion and relating the principles of these laws to simple everyday experiences. With the aid of a pendulum, the scientist explained to the students how a specific mathematical formula becomes a valid tool for the physicist in executing the work in the physical sciences. Students asked thought-provoking questions and the scientist reciprocated with probing questions to further challenge students' thought processes.

  Problem solving tasks required students to (1) apply the basic mathematical principles/concepts taught to real life situations and to (2) write comprehensive explanations of problem outcome. Many of the concepts learned at the elementary level are not ordinarily taught at that level. It was quite obvious that the students were having a great deal of fun in a learning atmosphere of healthy competition.

In another class, the scientist used a number of experiments in make-shift laboratories to introduce third grade students to the concept of force/pressure and how it operates in conjunction with other variables to create a variety of weather conditions. The making of a small-scale thunder storm was illustrated. In another experiment, an air-pump and a balloon were used to demonstrate the idea of how force operates in the launching of a rocket.

Experiments were kept short and in-line with students' attention span. Classroom activities required students to employ the visual, auditory and kinesthetic sense modalities in the learning tasks.

- Students experienced, firsthand, science and engineering operations through field trips and video tapes. Some 61% of the 28 teacher/emeriti respondents indicated that students were taken on field trips to science facilities; 36% reported that their students visited and interacted with working scientists and engineers and 29% said that their students observed scientists at work on video tapes and/or slides. See Table 2 and Figure 2.

- Emeriti report that levels of language/reading proficiency among a number of students needs to be significantly improved, in tandem with the ESME program, so that greater progress in concept analysis activities for more students can be achieved.

In effect, the lessons successfully fostered meaningful linkages between what is learned in the day to day classroom activities and what is practiced in the real world of the physicist, chemist, mathematician or the engineer.

Objective 3: Indicators of Heightened Student Interest

In answering this question, which addresses the issue of student interest in the sciences over the short term and in the long run, indicators on the attitude factor are summarized in Tables 3 through 6 and Figures 3 through 5 as follows:

- Table 3 and Figure 3 show that 56% of the student questionnaire respondents indicated that they are more interested in their ESME classes than they are in their regular classes, while only 8 % reported less interest.

A breakdown of the level of interest among students by o Sixty-one percent (61%) have developed greater confidence in their ability to do well in mathematics and science. This level of confidence may be related, in part, to the increased level of understanding of the subject matter students are experiencing.

Objective 4: Achievement Outcomes

Students' overall achievement profile in science and mathematics for a sample of the ESME students provide some indicators which appear to confirm our expectation that although the emeritus scientists do not teach the curriculum, the heightened stimulation in the sciences that students experience through the ESME program would help promote achievement in mathematics and/or science at a level higher than would have been probable without the program. For example, national norm-referenced data for the 1990-1991 and 1991-1992 school years reveal evidence of a systematic relationship between the ESME program intervention and accelerated student achievement. It is important to note, however, that the absence of pretest scores in some instances limited the ability of the analyses to control for the margins of initial group differences that might have been present at the pretest stage. Hence, caution is advised regarding the degree of the relationship reported.

The present national norm-referenced testing schedule in the DCPS does not allow for all students at all grade levels to be tested annually. As a consequence, the sample used to generate the findings for this achievement objective was limited to the number of matching test scores available for the target groups for the school years ending 1991 and 1992.

o In the school year ending 1991, that is, during the second year of the program, ESME students made some impressive NCE gains in mathematics concepts and applications (CA) scores over an equivalent group of students who were not served by the program (i.e., a control group). For instance, in one elementary school, the mathematics CA test scores of 24 fourth grade ESME students were matched with the scores of an equivalent sample of 21 control students. The results showed a statistically significant average gain of 16.4 NCE.* The data in Table 7 indicate that ESME group mean (average) score was 80.3 NCE or the 92nd percentile while, the control group mean was 63.9 NCE or the 74th percentile. Figure 6 represents the gains in percentiles.

*NCEs are Normal Curve Equivalent scores ranging from 1 at the base to 99 at the ceiling and are used as indicators of students' national norm-referenced performance levels within and across subject areas).

o A comparative analysis of the test results for the same two groups of students showed a similar accelerated achievement trend in science. Table 8 indicates that ESME students made gains of approximately 8 NCE over the scores shown in the control group. The actual scores were 73.9 and 66.1 NCEs for ESME and control groups respectively. Figure 7 shows matching percentile (%ile) score equivalents of 87 for the ESME and 77 for the control students.

o The achievement trend continued among fourth graders at a second elementary school except in this case the group means were generally lower. Analysis of the science and mathematics data for 35 ESME and 37 control students for the 1990-1991 school year indicated the following NCEs and %iles:

> For mathematics concepts and application skills, the ESME group mean was 62.7 NCE at the 73rd %ile and the control group was 49.4 NCE at the 48th %ile); so that the actual mean difference is 13.3 NCE or 25th percentile points. See Table 7 and Figure 6.
>
> In science, the means were 57.2 and 46.3 NCE with matching percentile points of 63 and 48 for the ESME and control groups, respectively. The actual mean difference is an impressive 11 NCE (approximately) and 15 %ile points. See Table 8 and Figure 7.
>
> The 1992 NCE science and mathematics test data for sixth graders in two additional elementary school taken together indicated that the ESME students made both strong and marginal increases over the performance of the control group of 26 students as follows:
>
> For the ESME group, Table 8 shows that the average increase in science skills over the performance for the control group was 9.4 NCE. The ESME group scored 67.3 NCE or the 79th %ile and the control group 57.9 NCE or the 64th %ile.
>
> In mathematics, the mean difference is shown in Table 7 to be 4.0 NCE with the ESME group scoring 70 NCE at the 83rd %ile and the control group scoring 66 NCE at the 77th %ile. Matching percentiles are represented in Figure 7.

o Analysis of the mathematics test data for school years ending 1991 and 1992 for 29 fifth and sixth graders in a fifth elementary school also revealed a trend in achievement gains. The 1991 mathematics concepts and applications scores grew from 40.1 NCE at the 32nd %ile to 43.8 NCE at the 39th %ile -- an increase of, approximately, 4 NCE or 7 %ile points (see Table 9). It is important to note that the low scores reported for these students should be viewed against the background that the school which these students attend is located in an area where a large percentage of the student population qualify as socially disadvantaged and the students' academic needs are often a great deal more severe than those of their more privileged counterparts. The results must therefore be viewed in the positive light of the sizeable achievement growth trend demonstrated.

o Using a sample of 147 students from both ESME and control groups, Pearson correlation analysis revealed a very strong relationship (.69) between students' level of reading skills and their mathematics and science proficiency. That means, the higher the skills in reading the higher the students' mathematics and science skill proficiency. This finding underscores one important observation made by the scientists which states that during their tenure of instruction with the students they were able to achieve greater progress in concept analysis activities in instances where students had higher levels of language/reading proficiency.

Other Evaluation Observations

Additional information was gleaned from the ESME volunteers and teachers. A synopsis of the responses is given below.

o Teachers have noted positive, incremental changes in students' behavior that are attributed to ESME program effects. These include greater interest in science and technology in and out of the classroom as well as for a future career. Teachers report also that students are now demonstrating greater responsiveness to analytical tasks.

o In some instances, emeriti request further assistance in instructional techniques to improve their effectiveness in the classroom. One-third of the 15 emeriti who responded to the questionnaire indicated that they needed additional help in devising teaching methods and hands-on experiments.

o Volunteers suggest that better organization of field trips, more contact with teachers, as well as more hands-on training for younger students would improve program efforts.

o Teachers and ESME volunteers see the strengths of the program in the enriching interaction between students and scientists/technologists, as well as the broadening of career horizons of the students.

o Emeriti and teachers together view the program as very motivational to students.

All these pointers confirm that the program is generally headed in the correct direction and that solutions to current problems are attainable.

SUMMARY

The evaluation concludes that the ESME program is beginning to achieve its goal of motivating greater student interest in the learning of mathematics and science. At present, some 730 students in public schools in the District of Columbia are being introduced to a range of scientific and engineering expertise in fields such as physics, chemistry, biology, geology and engineering. With the potential for significant growth in the number of students involved in the program, there is an obvious need for additional equipment and instructional material to enable greater student participation.

In the teaching process, scientists combine direct instruction on higher-order skills with activities that encourage students to (1) think profoundly about concepts and (2) explore mathematical formulas as analytical tools in the application of science concepts. The net effect is that students are developing greater interest and achievement skills in the sciences and are enjoying the challenges in problem-solving and hierarchical concept analysis. With impetus from this level of success, the program is well poised to achieve its long-range objective of keeping students studying mathematics/science at more advanced levels and, ultimately, steering them towards career paths in the science and technical fields.

TABLES AND FIGURES

Table 1 - Methods of Instruction Used in Classrooms as Reported by Teachers and ESME Volunteers

Method of Instruction Used Independently and Interchangeably	Teachers/ESME Volunteers	
	Number	Percent
Lecture/Demonstration	24	85.7
Hands-on Experiments	19	67.9
Problem/Concept Analysis	13	46.4
Discussion/Questions	26	92.9
Field Trips	7	25.0

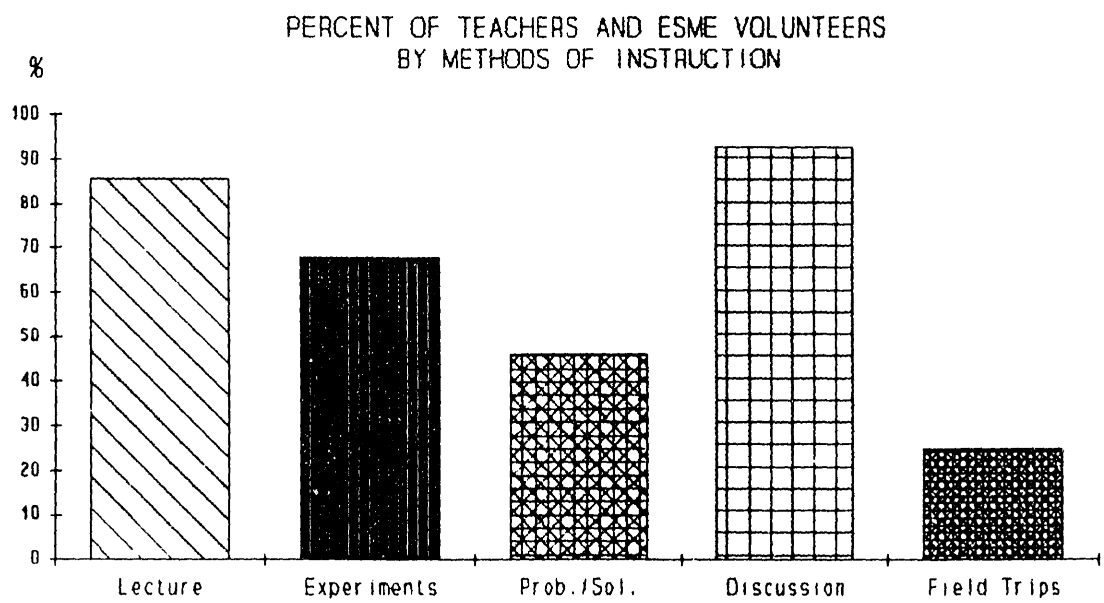

Figure 1

Table 2 - Percent of Teachers and ESME Volunteers Reporting Students' Field Experience Activities

Students' Field Experience Activities	ESME Volunteers	
	Number	Percent
Field Trip to Science Facility	17	60.7
Visit Scientist/Engineer	10	35.7
Observe Scientists/Engineers at Work (Video/Slides)	8	28.6

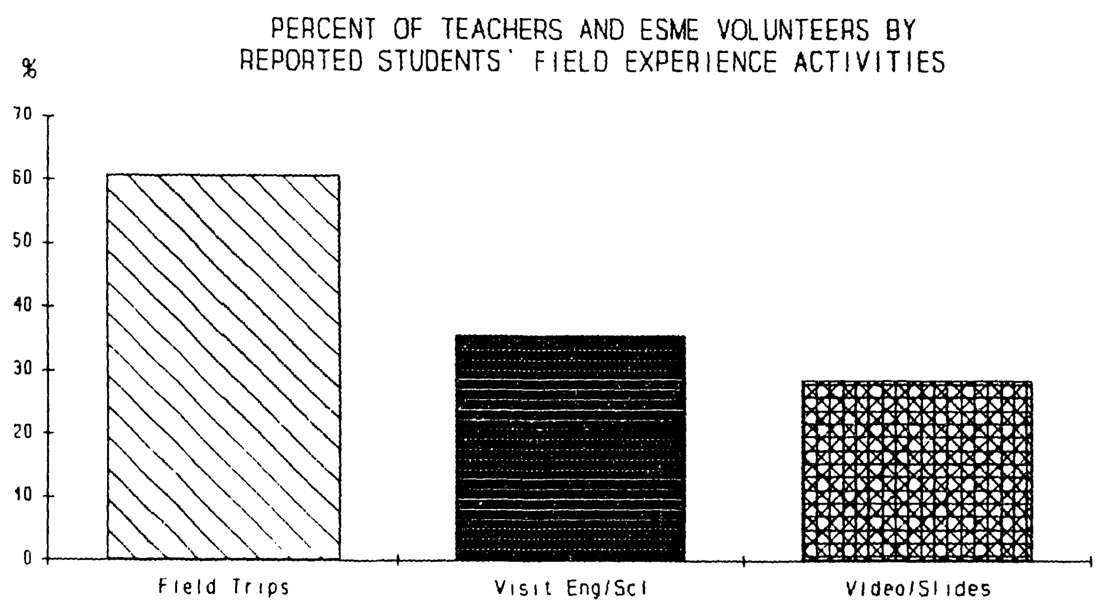

Figure 2

Table 3 - Percent of Students by Level of Interest Compared to Regular Classes

Level of Interest	Students	
	Number	Percent
More	122	55.7
Same	79	36.0
Less	18	8.3
Total	219	100.0

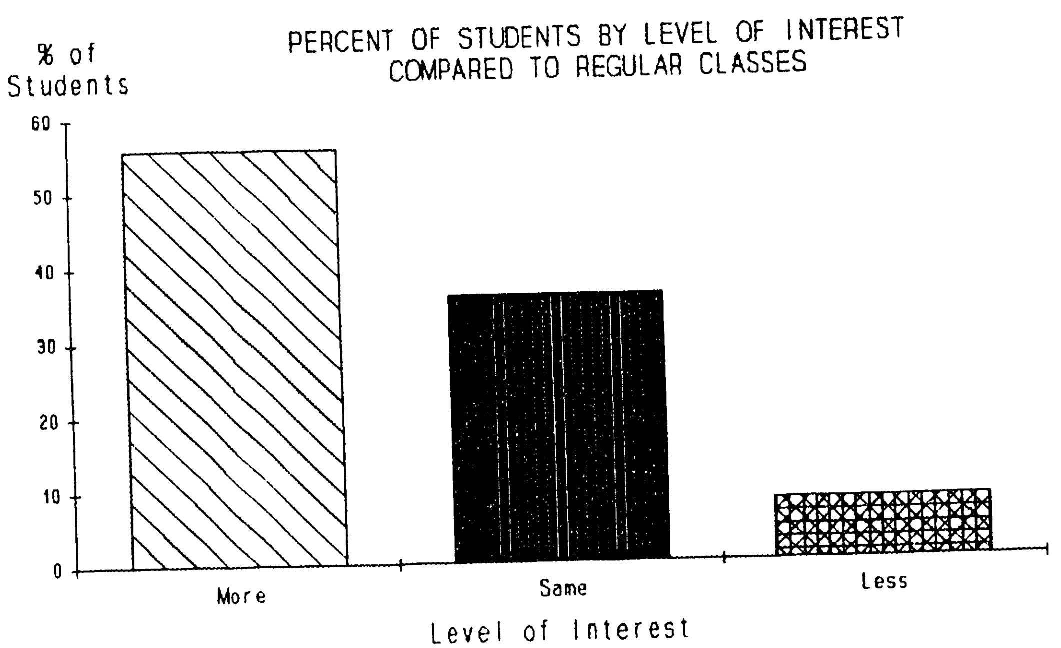

Figure 3

Table 4 - Percent of Students Within an Area of Emeriti Specialty by Level of Interest When Compared With Regular Classes

Students' Level of Interest	Area of Specialty of Emeriti		
	Mathematics	Science	Engineering
More	4.0	53.6	66.0
Same	32.0	38.0	22.0
Less	64.0	8.4	12.0
Column Percent	100.0	100.0	100.0

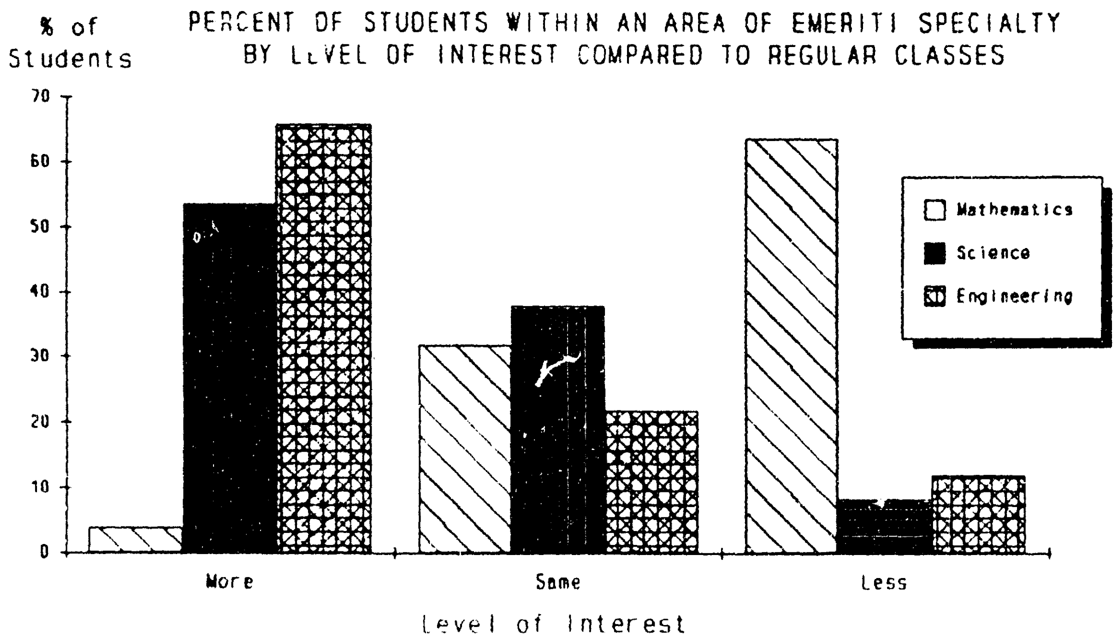

Figure 4

Table 5 - Student Attitude Survey

STATEMENT	Student Response	
	% True	% Other
I find I want to spend more time doing Mathematics/Science	55.7	44.3
I enjoy the Science/Engineering sessions with the emeritus volunteer	79.9	20.1
I feel better about my ability to do Mathematics/Science now	61.2	38.8
I look forward to my classes and activities with the emeriti volunteers	74.9	25.1
I do not like the ESME classes; I am scared to have to take them	5.5	94.5
I have learned a lot of new and exciting things in Science/Math since I started	87.2	12.8
My parents/guardians encourage me to continue doing my best in ESME program	63.9	36.1
I have a better understanding of Science/ Engineering ideas when I visit the site	75.8	24.2
I would like to become a Scientist/Engineer similar to the one who worked with my class	35.6	64.4

Table 6 - Percent of Teacher Respondents: Estimated Percent of Students With More Positive Attitudes

Estimated Percent of Students with More Positive Attitudes	Teacher Respondents	
	Number	Percent
Under 10%	1	7.7
10 - 20%	0	0.0
20 - 50%	3	23.1
Over 50%	9	69.2
Total	13	100.0

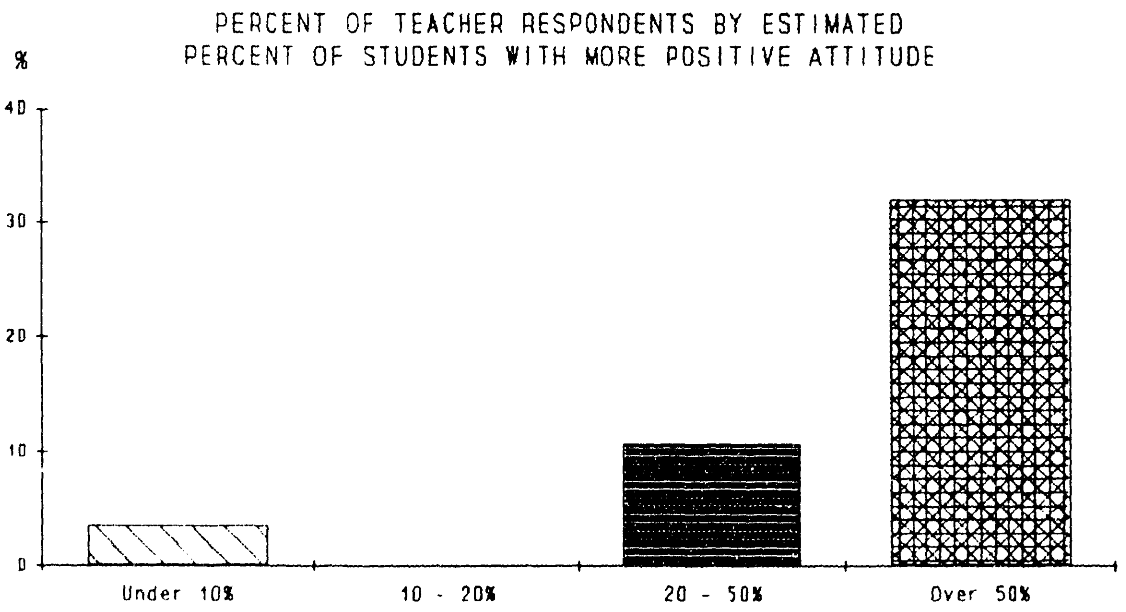

Figure 5

Table 7 - Descriptive Statistics: T-Test of NCE Mathematics Concepts and Applications (CA) Gains Across ESME & Control Groups

Sch	Group	Grade	No of Cases	Mean NCE Score	Mean Differ.	T-Value	Signif Level
E#1	ESME	4	24	80.3	16.4	3.19	p<.01
	Control		21	63.9			
E#2	ESME	4	35	62.7	13.3	3.20	p<.01
	Control		37	49.4			
E#3 & E#4	ESME	6	32	70.0	4.0	0.76	
	Control		26	66.0			

Table 8 - Descriptive Statistics: T-Test of NCE Science Score Gains Across ESME & Control Groups

Sch	Group	Grade	No of Cases	Mean NCE Score	Mean Differ.	T-Value	Signif Level
E#1	ESME	4	24	73.9	7.8	1.40	
	Control		21	66.1			
E#2	ESME	4	35	57.1	10.8	3.51	p<.01
	Control		37	46.3			
E#3 & E#4	ESME	6	32	67.3	9.4	2.04	p<.o5
	Control		26	57.9			

Table 9 - Descriptive Statistics: T-Test of Pre-Posttest NCE Gains in Mathematics CA Skills for ESME Group

Sch	Group	Grade	No of Cases	Mean NCE Score	Mean Differ.	T-Value	Signif Level
E#5	Pretest	5&6	29	40.1	3.7	1.37	
	Posttest			43.8			

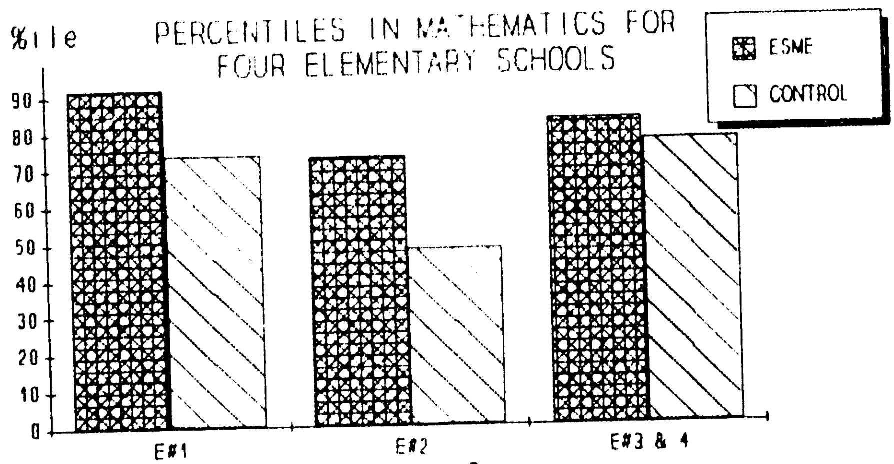

Figure 6

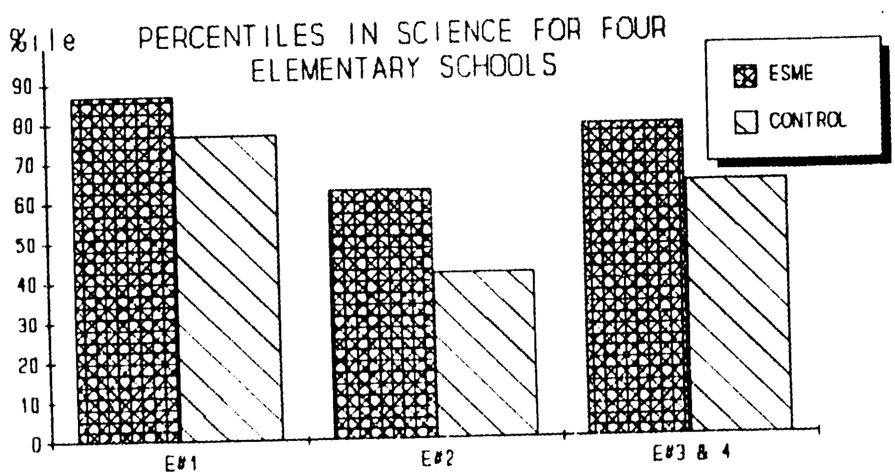

Figure 7

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