School Science Comes Alive
Phase Three

Final Report

Principal Investigator: Dr. Frederick F. Hartline
Department of Physics and Computer Science

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CHRISTOPHER NEWPORT UNIVERSITY
NEWPORT NEWS, VIRGINIA 23606-2998

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Abstract

Phase 3 of the School Science Comes Alive Program (S^2CAP) created an exciting, science-enrichment experience for third, fourth and fifth graders and their teachers and enhanced the science-teaching skills of teacher teams at each of four participating elementary schools on Virginia's Peninsula. The schools involved enroll a majority of Black students, many of whom are from economically disadvantaged households. Designed to build on the highly successful S^2CAP program of the preceding two years, this project brought college faculty together with classroom teachers and trained volunteers in a cooperative effort to make a lasting difference in the quality of science education at the four schools. In total, this program touched approximately 1000 the school children, more than half of whom are black, giving them direct and indirect exposure to the spirit of inquiry and adventure of the world-wide science community.

In S^2CAP Phase 3, a large measure of responsibility was placed on the classroom teachers, thus creating a more sustainable partnership between college faculty and grade school teacher. Our college physics professors coached and supported teams of teachers from each school at intensive training workshops. A volunteer program provided each teacher with one or more trained volunteers to assist in class with the hands-on activities that have been central to the S^2CAP program. Most of the equipment for these activities was constructed during the workshops by the teachers and volunteers from low cost materials provided by the program. Two types of volunteers were enlisted: science smart black college students and technically trained retirees (many of whom are ex-NASA employees).

One goal of this program was to increase the numbers of minority students who see science as an interesting and exciting subject, to make the science period a time which students look forward to in the school day. Such an attitude is expected to translate naturally into a higher interest in science and engineering as a career for these students.

A second goal was to create a sustainable improvement in the way science is taught at the elementary level. By the end of the program we expected that our teachers would be significantly more self reliant in using hands-on-activities as a part of their science curricula than they were prior to their involvement with S^2CAP.

In summary, S^2CAP Phase 3 offered intensive training workshops for teachers and supporting volunteers followed by stimulating hands-on activities in the classroom for the children. These components combined to amplify the experience, enthusiasm, and ideas of our scientists in a way that complements the normal elementary school curriculum in each of the two school systems involved.

Introduction:

During the three year duration of the S²CAP, program staff from the Department of Physics and Computer Science at Christopher Newport College successfully reached the entire third fourth and fifth grades at four predominantly black schools on the Virginia Peninsula. By all reports the program was hugely successful: evaluations by teachers and students alike were overwhelmingly positive. Our department learned that it can make a difference in attitudes of the students and the teachers toward science with a well-planned outreach program. We believe this program had a significant impact on over 1000 students, most of them from minority families, bringing to them some of the excitement of scientific research, and involving them in special demonstrations and hands-on activities.

Consider the response of a black, third-grade boy when, Dr Fred Hartline promised to pump water out of a dish with an empty Coke can. The students, including this young child, crowded around as Fred began to heat the can with a small burner. "Now watch closely," shouted Fred as he plunged the hot can, top-downward, into the bucket of water on the table. The swish of steam and the dramatic crunch of the metal as the can crushed shocked and delighted the children. Two fell over backward in their chairs. And the little boy is heard spontaneously pleading, "Do it again; do it again," as Fred calmly turned the can upside down and the children watched the water pour from its opening. What a pump! This episode from one of many classroom visits was captured on videotape.

In another classroom the students in each class lined up in excitement to try, one after the other, to pull a steel plate off of an electromagnet that was energized by a small generator turned by the smallest student in the class. The heftiest fourth grader struggled to separate the plate from its base--to no avail. Yet when CNU's Dr. Raouf Selim disconnected one wire in the circuit it lifted off easily.

After learning about earthquakes using the S²CAP earthquake simulators, students in each 4th grade class were invited to build structures representing houses using simple materials like paper, clay and toothpicks, soda straws and marshmallows, or sugar cubes. When our scientists returned the following week with testing machine, there was enormous enthusiasm, anticipation, and speculation as each house was tested to destruction.

These and other hands-on activities and demonstrations convey often-missed essential messages to the young learners in our program: that science is interesting, that science is relevant, that science is fun to do. We expect that more minority students interested in science translates into more minority science majors in colleges, and in science & technology related careers.

Goals of the Project:

The overall mission of project was to increase the number of minority students qualified for and interested in careers in science and engineering. During the first year of the project, Phase 1, we reached over 300 third grade students at four high-minority elementary schools on the Virginia Peninsula. the second year, the program and enrichment continued for these students as they progress through 4th grade. Phase 3 reached most of the same students once again in 5th grade, as well as touching students in 3rd and 4th grades. Both Phase 2 and Phase 3 supported the teachers in the earlier grades in continuing their science efforts with new children. As a result, in Phase 2

there were over 600 students participating in the program; in Phase 3 the count was approximately 1000. These students, now in middle school, are being followed by others who hopefully find their science lessons more relevant and more interesting because their teachers received hands-on materials and training in S^2CAP over the past several years. The success of the elementary school program eventually is expected to be felt in the high schools as the younger students progress in their education.

Rationale:

Regrettably science education in the first five grades consists largely of learning scientific "facts" out of textbooks and workbooks. While these textbooks contain suggestions for hands-on experiences, most elementary school teachers at this level do not have the time, the materials, or science training to make these activities successful. Most teachers choose to ignore these aids, even though extensive research has shown that hands-on experiences build more effectively on the primary learning modality of these students.

Elementary school students are ideally suited for a hands-on approach. They are generally enthusiastic and work well at classroom activities involving small groups. For older students such hands-on activity takes place in a college or laboratory settings. The students get the double benefits of doing real science and becoming familiar with the collegiate atmosphere. Because constant supervision is required for elementary school students, and because these students are comfortable with their friends well-established classroom setting, it is impractical to plan major activities outside of class. The activities we develop are done in the students' own classrooms. Consequently it is neither practical nor appropriate to separate students for special treatment. In order to reach as many Black students as possible, we selected S^2CAP elementary schools from among those on the Peninsula with the largest minority populations.

Description of the Project:

Phase 3 of School Science Comes Alive was the final segment of a three year science-enrichment program bringing top-quality hands-on science experiences to four targeted elementary schools on the Virginia Peninsula. Built on the successes of the of the first two years, this final year of the project focused primarily on third and fifth grades, addressing six curricular units during the January to January year: For fourth grades, we provided special challenge projects encouraging the students to apply teamwork and creative problem solving to real-world problems that could be modeled simply and tested in class so that the students came to appreciate that science and learning are important to them and to society.

The three foci of Phase 3 were as follows:

3rd and 5th grade focus

Because of the elementary school curriculum spiral, fifth grade science curricula overlap strongly with the third grade curriculum. Taking advantage of this commonality, we offered joint workshops where 3rd and 5th grade teachers worked together on similar activities that were been adapted to their own grade levels.

1. Training & materials development workshops: For each of the six units, Our staff scientists hosted a 6 hr workshop for teacher/volunteer teams. Each team became familiar with the subject matter, assembled and organized 5 or 6 sets of apparatus, and learned how to use use the apparatus in a classroom environment

2. In-class activities: Teacher/volunteer teams, using the materials they had assembled, ran the hands-on activities in each class of the grade level.
   Teachers were responsible for prefatory and followup sessions to maximize the educational value of each unit.

3. Scientist's visits: Staff scientists or scientist volunteers visited each school during the grant year. During these visits each of the 32 classes participated in exciting hands-on activities, demonstrations, and/or challenge projects.

4th grade focus

1. Challenge project workshop: Our staff scientists hosted a 3 hr workshop for 4th grade teachers and volunteers to familiarize them with the four 4th grade challenge projects. Teachers & volunteers learned how to run each project, and decided how to schedule the challenges into their own curricula

2. Challenge project in-class activities: Teachers and volunteers, using the simple materials we provided, ran the challenge-projects in their classes. Teachers were responsible for prefatory and followup sessions to maximize the educational value of each challenge.

3. Scientist's visits: Staff scientists or scientist volunteers visited each school twice, meeting and interacting with the 4th grade, and sharing exciting demonstrations, challenges, and hands-on activities.

Teacher's guide to S^2 CAP Materials:

S^2CAP staff scientists developed and tested more than 80 hands-on activities over the course of the three year project. Written instructions for making the apparatus and for using each of the S2CAP hands-on activities, including copy masters for all handouts, and suggestions for teachers are currently being compiled. In December of 1994, teacher participants from the program gathered at CEBAF in Newport News to review the activities and suggest refinements. This workshop was cosponsored by the DOE's Continuous Electron Beam Accelerator Facility. Materials for limited in-house publication will permit us to provide these materials at no cost to teacher-participants in the program, and to other preservice and inservice teachers in the region.

Overall Impact of the Project

The number of students directly reached by S^2CAP-Phase 3 is shown in Figure 1. The timeline of of a single curricular "unit" is shown in Figure 2.

The project included two elementary schools in Hampton and two in Newport News. Each of these four schools enrolls a student body that is predominantly Black. In the long term, we expect a lasting change in the way science is taught at each of these four schools, and throughout the region. We expect that our teachers will continue to use the activities we have trained them to use; we anticipate that many of our volunteers will continue their involvement in the science classrooms of the schools in Hampton and Newport News; and dissemination of our activities and instructions will reach many students in the school systems of the Hampton Roads Peninsula.

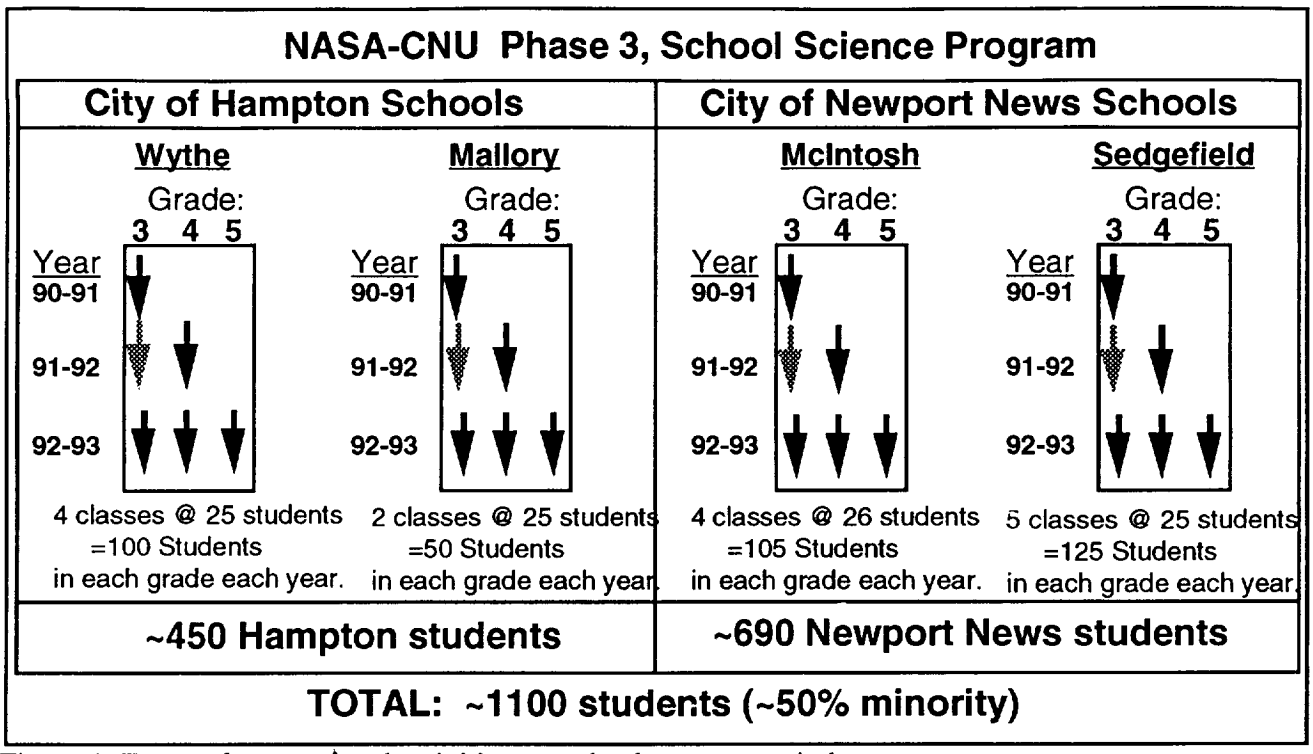

Figure 1: Focus of grant related activities over the three year period

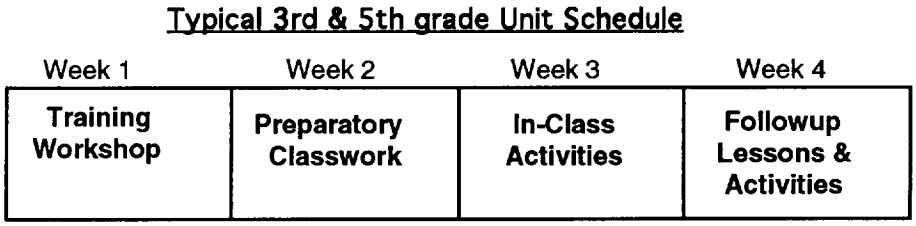

Figure 2

Evaluation of the Project:

We have monitored the effectiveness of this program through limited testing of science related attitudes and skills both in target and in control classrooms, by surveying teacher and volunteer attitudes towards the project, by evaluating the teachers' self assessment of science teaching efficacy, and by comparing student performances on Iowa tests administered by the school systems to all fourth graders.

S2CAP Phase 3 Accomplishments:

Third & Fifth Grade Program

Workshops for Teachers & Volunteers: February, March, April, & May

S^2CAP third& fifth grade workshop were and attended by 17 third grade teachers, 16 of whom were teachers with the program in the previous year, and one whom was new to the program. The workshop featured refresher activities based on the materials and

presentations used in the third grade classes of the previous year. After the refresher activities, the teachers decided which activities they most wanted to have brought into their classes during our visits.

Classroom visitations

During one week in November Drs. Hartline and Selim visited each third grade class at each of the four schools in the School Science program, bringing with them the S²CAP stream table activity on changing landforms and land use planning. This activity was enthusiastically received by the approximately 380 third graders in the four schools. A second third grade workshop and classroom visits were held in May.

Fourth Grade Program

Units on Matter & Energy, Electricity & Magnetism, Earth Sciences, and Planetary Science were completed in November, January, March, and May '92 respectively. The contents of these units is described on the following pages.

Extension of Phase 2 funding into the third year of the program

Funding from S²CAP Phase 2 was rolled into the third year of the program: from October 1992 through May 1993. Phase 3 (encompassing Spring and Fall '93) was similar to Phases 1 and 2, but shifted the emphasis toward supporting and encouraging the reshaping of science teaching methodology among the third fourth and fifth grade teachers at the four target schools. Phase 3 activities included a workshop for fourth grade teachers, 8 workshops for 3rd and 5th grade teachers, and two visits to each school with hands on activities supported by S²CAP staff for each 3rd-5th grade classes.

Summary Assessment

From the point of view of the "visiting" scientists, our visits to the classrooms and the hands-on activities we ran with third and fourth grades over the course of this project have been highly successful, and greatly enjoyed by the students and teachers alike. In addition, the teachers report that the supplemental materials (books and supplies) that we have provided are highly valued and continue to be used in their classes. It is evident from the teachers' and students' enthusiastic reception that materials and activities such as those we have provided do much to enrich the elementary school science curriculum. What is not clear is the extent to which these activities will continue to be used by the teachers who participated in our program. We have anecdotal reports from several of the teachers that they continue to use the activities this current year.

Spring '93 Teachers' S²CAP Assessment Survey.

At the final 3rd & 5th grade Teachers' Workshop, each teacher was asked to respond to a series of questions designed to evaluate the impact of the School Science program and activities on her

Spring '93 Teachers' Self Assessment of Science Teaching Efficacy

We plan a more thorough assessment through a follow-up questionnaire this as part of S²CAP Phase III.

Fourth Grade Unit 1 Matter & Energy

Summary of Workshop Activities

Matter & Energy puzzle
- Atmospheric crushing of a steam filled coke can
- Doing the same work with a can crusher.

Concept of Mass
- Foil covered brick vs styrofoam block, mass contrasted to volume

Concepts of Energy (kinetic & potential energy)
- using toys to talk about energy of motion and stored energy .
- Energy & Rockets--Applying energy concepts to pressurized-water rockets

Matter & Atoms
- Pictures of atoms & molecules (atomic force microscopy)
- Nuclear physics simulations
- Identifying hidden shapes,
- Measuring the area of a dime by probability
- Measuring density of liquids
- Layering liquids of different densities
- Cryogenic phenomena
- Liquid nitrogen demonstrations

Summary of science materials given to each school (for this unit):
- Mass concepts brick & foam block kit
- Classroom mass balance
- 10 Graduated cylinders
- Rocket launchers
- Book on Matter & Energy

Summary in-class activities
- Crush the Coke can
- Energy & Toys
- Water Rockets
- Liquid nitrogen demos
- Teacher-run activities

Fourth Grade Unit 2 Electricity & Magnetism

Summary of Workshop Activities

Statics Electricity
Van de Graaff Generator demonstrations
Conductivity
Testing electrical conductivity in objects and liquids
Electric circuits continuity puzzles
Electric circuits
Series and Parallel circuits.
Electromagnetism
Visualizing magnetic fields in 2D and 3D
Magnetic field from a current carrying wire
Magnet and coil: Generating electricity with motion
Motor & generator activities
Nail electromagnet activities
Electrochemical cells
A "battery" from nail or foil, wire, and liquid

Summary of science materials given to each school (for this unit):

Magnetic field bottle (make-n-take)
Iron-filings in a sealed frame (make-n-take)
low cost continuity tester (1 per teacher make-n-take))
Series Parallel kit (batteries, holders & circuits)
Bag of Magnets
Bag of compasses
Set of ALNICO magnets
100 low-voltage lightbulbs with bases
Magnetic circuits activity center
Galvanometer for electromagnetism demos
Nail-electromagnet kit (make-n-take)
2 Genecon generator kits
Electric motor kit
Book on Electricity & Magnetism activities

Summary in-class activities

Van de Graaff Generator fun
Testing for conductors
Electric circuit puzzles
Series & parallel circuits
Electrochemical cells
Electromagnetism: Wire & compass, electromagnet, moving magnets and coil, motors & generator
Teacher-run activities

Fourth Grade Unit 1 Matter & Energy

Summary of Workshop Activities

Earthquake Activities
- Earthquake simulator
- Earthquakeproof house contest.

Earth resource activities
- Understanding Landsat
- Searching for Ore activity
- Solar energy: model solar homes, solar boat race

Weather Activities
- Humidity measurements: sling psychrometer , dewpoint on a can
- Exploring air pressure: barometer in a bottle
- Wind speed from a pingpong ball

Summary of science materials given to each school (for this unit):

- Earthquake simulator apparatus
- Chesapeake Bay LANDSAT poster
- Earth from Space poster
- Solar energy kit
- Sling Psychrometer kit
- Dewpoint can kit (make-n-take)
- Barometer & Bottle kit
- Anemometer kit
- Book on weather measurement activities

Summary in-class activities

- Talking about Earth resources
- Hunting for Ore activity
- Earthquake simulator activity
- Earthquake contest.
- Teacher-run activities

Principal Investigator:

Frederick Hartline, the project director for Phases 1, 2, and 3 of School Science Comes Alive, has extensive experience in science research and in science education. He has most recently developed new online lab course for both CNC's physics course for non-science students based on his previously developed lab curricula and for physics majors and non-majors students. He has written four lab manuals, A Hitchhiker's Guide to Phenomena I & II, and the Flip Side of Physics, I & II; and he was the co-director of the MIRACLES program at CNU (a "Saturday Academy" for middle schoolers). Besides teaching hands-on science labs for CNU's MAT graduate program, He is using S^2CAP curricular materials in his undergraduate Physical Science courses for teachers, directed by Hartline and co-taught with experienced master teachers from the local community. Previously he and a professor in education have collaborated to teach a highly successful hands-on science course for elementary school teachers that drew a sell-out crowd of inservice teachers from all four peninsula school districts. His earlier work at the Lawrence Hall of Science focused on the development of science education materials for lay-adults and children. For a number of years preceding that he developed and tested educational materials in preschools and elementary schools in Orinda, CA.