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ABSTRACT

The Connecticut Museum Collaborative is a partnership between four different science museums. The collaborative's main goal is to improve middle school teachers' knowledge and skills in science, mathematics, and technology, and to support the development of relevant curriculum. This report is the third year formative report of the Collaborative's operations by Curriculum Research and Evaluation (CRE). Qualitative and quantitative methods of data collection were used including site visits, interviews, document analysis, and surveys. Results indicate that the Collaborative has accomplished its objectives for year three at a reasonably high level. Data from the middle school teachers, students, museum staff, and key participants reveal that the Collaborative provides a rich and meaningful opportunity for informal science education. The main issues of the program include improving the level of teachers' and school administrators' commitment and initiative taking, increasing parents' participation, and meeting the high cost of bus transportation for classes. The report is divided into the following sections: introduction; key features of year three; descriptive data on each of the museum centers; discussion of survey data; main themes of the third year formative evaluation including issues; and summary, conclusions, and recommendations. An appendix provides examples of survey instruments used. (JRH)

The Connecticut Museum Collaborative for Science Education

1995-1996

Annual Report

September 1996

by

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Abstract

In 1993, the Connecticut Museum Collaborative received a grant from the National Science foundation to develop a partnership between four different science museums. The Collaborative's main goal is to improve middle school teachers' knowledge and skills in science, mathematics, and technology, and to support the development of relevant curriculum. Through workshops on methods and content for teaching science, visits to museum exhibits and laboratories, and field trips to remote locations the museum staff provide the teachers and their students with direct exposure to the worlds of science and informal science education. Also, the Collaborative emphasizes team building for curriculum development, linkages between urban and suburban school districts, and parent and community involvement. During years two and three of the program, the Collaborative added two additional science museums, whose focus is on resource recovery and solid waste disposal.

This is the third year formative report of the Collaborative's operations by Curriculum Research and Evaluation. The comprehensive plan for evaluation of the Collaborative includes planning, formative, and summative phases. Methods of data collection and analysis include qualitative and quantitative procedures. The principal evaluator visits the museum centers for observation of the Collaborative's activities, interviews with key participants, and collection of documents. CRE uses survey instruments that are keyed to the program's goals and objectives to provide data on teachers' and students' perceptions of the program's impact on their science education. Also, the evaluation process examines the Collaborative's contribution to systemic change of science education in Connecticut.

Results indicate that the Collaborative has accomplished its objectives for year three at a reasonably high level. Data from the middle school teachers, students, museum staff, and key participants reveal that the Collaborative provides a rich and meaningful opportunity for informal science education. During year three, approximately 850 middle school students and their 40 teachers from 9 different school districts participated in the Collaborative's various programs. Also,

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during the third year, the Collaborative successfully completed its curriculum guide for science education that is based on the national standards for science and mathematics education. The Collaborative has scheduled a fall 1996 conference, during which time it will offer workshops that formally introduce teachers to the curriculum guide.

The main issues of the program are improving the level of teachers' and school administrators' commitment and initiative taking, increasing parents' participation, and meeting the high cost of bus transportation for classes.

The Collaborative's plans for its fourth year include devising strategies for addressing the issues it faces, as well as continuing to offer the workshops and museum visits of the past three years. Finally, the Collaborative has written a proposal for a grant to institutionalize its program for the preservice and inservice education of teachers at a local university.

Acknowledgments

Curriculum Research and Evaluation wishes to thank all of the key players at the museum centers for their willingness to provide comments and other data on the program's development. They are: Cheryl Burke, Valerie Cournoyer, Jonathan Craig, Valerie Knight-DiGangi, Linda Malkin, Brian Parks, Jeff Pearson, Adam Shopis, and Dr. Albert Snow. The evaluation team also expresses appreciation to the teachers, students, and other museum staff for their assistance with data collection. Finally, CRE wishes Dr. Albert Snow the very best in his new adventure at McGill University. We will miss him and we sincerely hope that he returns frequently to survey the Collaborative's operations. Good luck Dr. Snow! And thanks for all your help.

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1995-1996

Annual Report

1. Introduction

The Connecticut Museum Collaborative for Science Education began in October 1993 with a grant of $1,963,178 from the National Science Foundation. The Collaborative's[1] main purpose is to use science-rich institutions to train middle school teachers in science and in methods of teaching science. The project's main office is located at The Discovery Museum in Bridgeport, Connecticut. The four science-rich institutions that were in the original proposal continue their active involvement. Included in this group are: The Discovery Museum, The Maritime Center at Norwalk, Mystic Marinelife Aquarium; and Talcott Mountain Science Center. During the past two years, the Collaborative added two other museums. They are the Children's Garbage Museum and Education Center in Stratford and the CRRA-Mid-Connecticut Project Visitors Center in East Hartford. These new institutions emphasize environmental concerns of science that are associated with solid waste recycling. Also, they are full partners in the Collaborative, but they do not receive funds from the grant.

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[1]The project is known by the following terms: Connecticut Museum Collaborative, Collaborative, and CMC.

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The Collaborative interacts with other agencies in the state that are concerned with the improvement of science education. In particular, the project coordinates its purpose, materials development, and program with the State Department of Education and Project CONNSTRUCT, Connecticut's Statewide Systemic Initiative. The Collaborative intends to improve the science education of the State's 5,000 middle school teachers, and to have a positive impact on their students through both direct and indirect means.

Objectives of the Collaborative

The objectives of the Connecticut Museum Collaborative are:

- *To provide new and additional education in both content and instructional strategies for middle school science teachers in Connecticut, using the resources of the State's science museums and centers.*
- *To provide resources, catalysts and examples for improving science, mathematics, and technology education in middle school classrooms; and to support school curricula with related activities in informal settings.*
- *To produce materials for the continuing professional development of teachers and in-service workshops, thereby accelerating the rate of improvement in science education.*
- *To engage the intellectual capacity of business and industry in the improvement of science education.*
- *To prepare a core group of middle school teachers to serve as peer group team leaders for curriculum development at the school, district, and state levels.*
- *To conduct inservice activities using the same instructional strategies that the teachers will apply to the education of their students.*
- *To stimulate parents to become informed advocates for better quality and more universal science, mathematics, and technology education in both formal and informal settings; and to encourage them to support their children's science and mathematics endeavors in the home and elsewhere.*
- *To provide a structure and vehicle for collaboration and linkages among the science museums and centers in Connecticut, the school districts they serve, area businesses, and Connecticut's systemic initiative for state-wide improvement of mathematics and science education.*

- *To provide a model for systemic change in science education in Connecticut and other states. The intent is to get the program embedded into the curriculum of the core group districts, as a standard for emulation.*

Summary of Findings

The data indicate that the Connecticut Museum Collaborative has accomplished its objectives for year three at a reasonably high level. Students, teachers, and key participants at the museum centers express agreement that the Collaborative is a vital program for improving the science knowledge and skills of teachers and students and for the overall improvement of science education in the State. This year, through its variety of museum programs, the Collaborative had a positive impact on approximately 850 middle school children and 40 middle school teachers. In all, 9 different school districts benefited from their teachers' enrollment in the Collaborative's professional development programs and class visits to the science museums.

The main issues of the Collaborative concern improving the initiative and commitment of teachers, scheduling visits to all of the museums by all of the classes, increasing the response of parents, and the high cost of busing. Near the end of the report there are recommendations for addressing these issues.

Methodology

This is the third formative evaluation of the Connecticut Museum Collaborative by Curriculum Research and Evaluation (CRE). The comprehensive plan for the program's evaluation is based on the program's objectives and includes planning, formative, and summative phases. Qualitative methods include interviews with key participants; observation of events and activities sponsored by the Collaborative, and collection of documents and artifacts produced by or purchased for the Collaborative. The principal evaluator attends most of the monthly Executive Committee meetings and participates in conferences where the Collaborative reports its results. CRE uses surveys to collect quantitative and qualitative data on teachers' and students' perceptions.

Organization of the Report

The organization of this report is as follows. First there is a discussion of the key features of year three of the Connecticut Museum Collaborative. The next section presents descriptive data on each of the museum centers. Then, there is a discussion of survey data that CRE collected from teachers and students who participated in the museum program. Then, the report presents the main themes of the third year, formative evaluation, including issues. Near the end are a summary, conclusions, and recommendations. An appendix provides examples of survey instruments that CRE used for quantitative and qualitative data collection.

2. Key Features of Year Three

The main players in the Collaborative have remained the same throughout year three. In fact, since the project began, personnel changes have been few. Those that occurred involved replacing people who sought positions elsewhere (Mystic Marinelife Aquarium and The Maritime Center at Norwalk) or adding assistants for scheduling museum visits and transportation (The Discovery Museum and Mystic Marinelife Aquarium).

Dr. Albert Snow, of The Discovery Museum, continues as the principal investigator who coordinates the project. Linda Malkin, also of The Discovery Museum, provides assistance with project management. (Linda Malkin will become principal investigator in October 1996, when Dr. Snow leaves the Collaborative for a position at McGill University.) Adam Shopis, of The Discovery Museum, is in charge of transportation scheduling for the Collaborative. Key participants at the other museums are: Valerie Knight-DiGangi, of the Children's Garbage Museum at Stratford; Cheryl Burke, of the CRRA-Mid-Connecticut Project Visitors Center at East Hartford; Brian Parks and Patti Hunter, of The Maritime Center at Norwalk; Jeff Pearson, of the Mystic Marinelife Aquarium at Mystic; and Jonathan Craig, of Talcott Mountain Science Center at Avon.

The Executive Committee of the Collaborative holds an official meeting at least once each month of the year. Its main order of business is the collaborative coordination of the museums' programs statewide. These meetings are the principal accomplishment of the Collaborative, since prior to its organization, there was no official or unofficial discussion concerning the coordinated development of museum programs on a statewide basis for science education. Every museum was on its own. In this past year, due largely to the issues surrounding

development of the curriculum guide, the Executive Committee often met on a bi-monthly and weekly basis to meet its production deadlines. All of the key participants are almost always in attendance at the Executive Committee meetings.

The real work of the Collaborative gets done in the Executive Committee meetings. These business meetings generally follow a pre-arranged agenda concerning topics or issues of interest to the Collaborative. There will also be discussions of related topics, such as the latest exhibits at different museums and new ventures or equipment purchases. Friendly, business-like, serious, cooperative, results-oriented, honest, and trusting are the terms that best describe the Executive Committee meetings. Members will say what is on their mind regarding issues and topics. Everyone willingly provides assistance with solutions to important problems.

During year three, the Collaborative made substantial progress on the curriculum guide for museum-based science and math education. Each museum took responsibility for development of a separate section in the guide pertaining to its program. Curriculum activities emphasize national standards for science education and their organization is by content areas and process skills. Also, teachers who use the guide should find that, in the least, it facilitates a school's articulation with the State's new science and mathematics curriculum frameworks.[2]

The Collaborative has plans for a fall 1996 conference on museum-based science education for its middle school science and mathematics teacher participants. The curriculum guide will be showcased in workshops. There will also be a discussion of evaluation of the project.

As in the previous two years, the Collaborative sponsors inservice sessions for middle school teachers, museum visits by the teachers and their students, outreach programs, and summer camps. There are nine towns and 16 schools participating in the program this year: Bridgeport: Harding High School, Dunbar School, Multi cultural Magnet, and Roosevelt School; Fairfield: Fairfield Woods Middle, Tomlinson Middle; Norwalk: Roton Middle, West Rocks Middle, Nathan Hale

[2]Curriculum frameworks are scheduled for release sometime in fall 1996.

Middle, and Ponus Ridge Middle; Wilton: Middlebook School; Weston: Weston Middle; Hartford: Quirk Middle; Bloomfield: Carmen Arace Middle; New London: Bennie Dover Jackson Middle; and Mystic: Mystic Middle. There is a total of 40 teacher participants. Many schools have from 1 to 3 teachers. Some, like Wilton's Middlebrook School and Hartford's Quirk Middle, had 6 teacher participants each.

The Collaborative continues to produce its newsletter, *The Collaborative Teacher*, in which it provides announcements regarding the collaborative's programs, requests for participation and sharing of ideas, teaser science problems with ideas for follow-up instruction, schedule of events, description of the overall program, and persons to contact for assistance.

3. Principal Centers of Operation

Most of the day-to-day operations of the Connecticut Museum Collaborative transpire in the different science-rich museums. What follows is a brief summary of events organized by the different museums.

The Discovery Museum

For the third year of the Collaborative, the objectives of The Discovery Museum are: to maintain the program that was started; to address particular issues, such as "sistering" of urban and suburban school districts; to continue the high quality programs for teachers and students; to get buses to arrive at their destinations—schools and museums—and on time; to complete the museum's curriculum materials; and to increase the involvement of families in the Collaborative.

According to Linda Malkin, one of the most valuable things about the Collaborative in this third year has been the monthly meetings with the other CMC members. She said,

> *"The chance to sit down with peers in these other institutions and discuss common problems with science education and the development of the Collaborative is a valuable use of time."*

Internally, operations at The Discovery Museum continue as previously with Dr. Albert Snow responsible for coordination of the CMC, Linda Malkin focused on financial records, and Adam Shopis managing transportation scheduling. Brian Parks, of The Maritime Center at Norwalk, shared responsibility for overall development of the curriculum materials. Jeff Pearson assumed responsibility for organizing the fall 1996 conference for middle school science teachers.

Key participants at The Discovery Museum judge their third year program to be successful overall. This past year, Discovery had a total

enrollment of 50 teachers, who attended the museum's professional development program in groups of 10 over a 5 day period. Teachers at Hartford's Quirk Middle School showed the highest level of loyalty to the program. Quirk is a large middle school where there are different clusters of teachers. It has sent whole teams of teachers each year for the past three years. Linda Malkin described the response at Quirk Middle as "a great success because of the teachers' high level involvement." There were 510 students who attended the Challenger and Science workshops or demonstrations. The summer institute had 12 teachers enrolled. Also, two teachers enrolled in the Challenger Workshop and 1 attended the Solar Car Workshop. Dr. Albert Snow participated in 2 teleconferences at Talcott Mountain Science Center.

To accommodate the teachers' schedules, the museum offered a more flexible design than in the past two years. Also, not only did the museum offer the programs they had planned, they prepared programs on different topics of interest to the teachers. This latter development was especially important to teachers whose school curriculum did not present a good match with the museum's original offerings.

In the opinion of teachers, students, and museum staff, the inservice program for teachers and the summer programs for students are highly successful. There is a lower rate of teacher involvement in both the second and third years than in the first year. Museum officials attribute this drop off in numbers of teachers to a saturation effect. In other words, the museum has nearly reached its limit of teachers with the programs it designed and offered. To attract more teachers or to get repeat involvement of previously trained teachers, it will need to redesign its inservice program. It is also plausible that the Collaborative has reached its limit with the teachers who are the movers and shakers in the schools it serves. The museum may want to consider development of high-end programs that have a built-in opportunity for these teachers to conduct the professional development of their peers.

The initiative to develop "sistering" relations between urban and suburban schools encountered difficulties. Apparently, the schoolteachers misunderstood the museum's role and their own responsibilities. More specifically, teachers expected more things from

the museum than it had actually planned and promised. A key element of this professional development program is for the museum to provide an appropriate place where sister schoolteachers could work collaboratively on curriculum and instruction. The teachers, instead of seeing the museum as a place where the would work together, expected the museum staff to present them with a ready-made product. In the words of one museum official, "It didn't work out."

Another area where The Discovery Museum encountered difficulty is with increasing the involvement of the children's families. As in previous years, the museum offers free memberships to the families of participating children. However, the museum has no mechanism for tracking parents' use of the memberships and, thus, no knowledge of the extent to which parents and other family members are involved as a result of the project. By contrast, the special event for families, which is held at The Maritime Center at Norwalk on behalf of the whole Collaborative, was successful, at least in getting a large number of local parents to attend. The Collaborative has discovered that parents' involvement is low, generally, and it is difficult to get parents from around the state to attend a family night at one of the museums.

The Discovery Museum plans to offer the same program for the 1996-1997 school year. However, since there is less money available to support the program, it will offer schools and teachers the opportunity to continue their participation, but with a requirement that they provide some kind of support. An example of the school's support would be to cover the cost of busing the children to the museum. An example of a teacher's support would be to offer to their peers workshops that are related to the museum's program.

The Maritime Center at Norwalk

The objectives for year three at The Maritime Center are: to keep up the momentum established in years one and two by providing Marine Study Cruises and the Future of the Oceans program for student participants, to provide the Jason Project for the same students, and to complete the curriculum guide.

Several special events were held at the Maritime Center. Included

was a parent orientation in fall 1995 to acquaint families with what their students would do all year. Also, in June 1996 there was a time for Family Fun with Science where parents were encouraged to come to the museum. There was a summer camp experience for all students in Norwalk, Wilton, and Weston. All students from these school districts who were in the program were eligible to attend. Also, the museum started discussions on all museums that might participant in its programs, including the Children's Garbage Museum and the New England Museum Alliance. The purpose was to explore the extent to which different museums could form teams to make a larger collaborative.

In December, Brian Parks assumed responsibilities of Denise Leone, who resigned from her position to take a job elsewhere.

Valerie Cournoyer and Brian Parks stated that they accomplished most of their objectives. Valerie Cournoyer said,

> *"The students, teachers, and curriculum are excellent. There are volumes of curriculum materials for the teachers to learn. The teacher training could be more extensive, but time is an issue for teachers an museum staff."*

An important finding is that the museum has discovered that the need exists for its informal science education programs. All of the teachers who have been involved have indicated (museum officials said that "the teachers plead") that they want this program to continue. This museum, like the others in the Collaborative, has succeeded in building an expectation and a momentum. Teachers know what the program is, they have come to expect it, and they want it. Museum officials add that, if the program is not wanted by the teachers, no matter how creative the museum can be, they will not come for the training nor will they bring their students.

Teachers request the "Future of Our Oceans" program, which is now available as a kit for the museum staff to take to the schools. This tactic is important for schools, like those located in Mystic, that are too far away for an easy trip to the Maritime Center. Instead, the museum goes to the schools.

According to museum officials, one aspect of the program that still needs more work is the family component. They would say that "it is not

as good as it should be." The Collaborative established a committee of parents, but according to museum officials, "it didn't work out so well. It was weak." For solutions, the museum officials are looking to the Connecticut Academy, which has a good track record for community outreach, for assistance.

Concerning the future, this museum has canceled for the time being its plans to use a Remote Operated Vehicle because none is available. Otherwise, its operations will continue as designed. The new topics for the Jason Project are: Volcanism in Iceland and Old Faithful in Yellowstone, Wyoming. The 1996-1997 teacher training at the Maritime Center will focus on this theme.

Mystic Marinelife Aquarium

In year three, the Mystic Marinelife Aquarium made one of its objectives to change the fall program from a whale watch component to "something else" that would maintain the museum's focus on marinelife, but would eliminate the problems that come with ocean cruises, such as long travel time on the ocean (3 hours), cancellations to bad weather at sea, long bus rides for students (2-2.5 hours), and no whales sighted while at sea. In the place of the whale watch, the museum substituted a food web course that would be presented by museum staff to the students' in their classrooms. In order to accommodate the circumstances at different schools, the course design has two versions, one that is for a 45 minute period and another that is for a 60 minute class period.

Another objective of year three is to continue the summer informal science program for students, but to focus on science and team building. According to Jeff Pearson, the idea is to bring children together from different communities, that is, urban and suburban, and get them involved in the collaborative study of different ecosystems. Included in the program are studies of plankton, sandy beaches, rocky shores, and fresh water ponds. A main idea in the program is that cultural systems, like these natural systems, are interconnected. Different communities of people, like different communities of plant and animal live, depend upon each other for development and survival. The program also

includes team-building activities, such as assigning groups to solve the problem of how to scale a 10 foot wall.

Mystic offered a one-week summer inservice program for teachers and it was well-attended. This program was scheduled again for fall 1995, but was canceled, due to low enrollment. Teacher participants report that they are very pleased with the program. Jeff Pearson acknowledged that there is criticism, but the only consistent statements involve teachers' complaints that "there is too much going on" or that they "have too many other obligations in the school day."

The museum conducted seal watches in spring 1996. These trips continue to be very popular with teachers and students. For many students, it is the first time they have had an opportunity to experience boating on the open water. Teachers get to see all of their students actively involved in the scientific method applied to a real life situation—data collection and analysis of the seal population in Long Island Sound. Mystic Marinelife Aquarium plans to continue the seal watch in spring 1997.

Mystic Marinelife Aquarium reported the following statistics on its programs for year three. August 1995 teachers' one-day workshop: 12 teachers; fall 1995 food web class at the schools: 31 classes, 31 teachers, and 889 students; winter through spring 1996 seal class at the aquarium: 32 classes, 32 teachers, and 869 students; seal watch: 9 boat trips, 32 teachers, and 967 students; 1996 summer camp program: 3 sessions, 23 students.

Talcott Mountain Science Center

Year three objectives for Talcott Mountain Science Center are: to include as many students as possible in the program; and to fulfill the obligation of the Collaborative, which is to bring students to the center for meaningful experiences in science. The following operations are included in the program at Talcott Mountain Science Center: add Adventures Along the Light Spectrum to enhance the idea of remote sensing and the view from space; to continue to work with meteorology, weather instruments for weather forecasting, and to understand how these instruments work; have each class use the Geostationary Earth

Orbiting Systems (GEOS) for the study of weather fronts and cloud formation; provide opportunities for students to use the Doppler Radar; and introduce students to the computer lab where a new multi-media Macintosh computer is set up for production of video forecasts.

Jonathan Craig, of Talcott Mountain Science Center, describes their program in the following terms: "We were successful, very much so. All of the students were very enthusiastic. The teachers gave very good feedback." He attributes the success of the program to the following sources: a professional and enthusiastic staff, the center's ability to offer state-of-the-art equipment, the use of authentic situations with current weather conditions, and activities that were fun for the students and teachers alike.

There were no shortfalls in the third year. Museum officials report that they would have preferred to have larger numbers of participants from the Hartford public schools and more students attending the summer programs. They have implemented strategic plans to increase these numbers.

In an effort to get more students from the Hartford schools, Jonathan Craig personally visited the urban schools to encourage teachers to get involved and to recruit students for the summer programs. As a result, there was an increase in participation from Hartford. The center's original goal was to have groups of 30 students each from Hartford and its sister community, Bloomfield. According to Jonathan Craig, "This year we did better than last year. We went from 16 to 37 students for the summer program. There were 10 or 11 students from the Hartford schools in the group." Also, the center was not pleased with the low attendance of parents, so it opened more Member Evenings to the Collaborative than it had in the past two years.

Concerning plans for next year, Talcott Mountain Science Center intends: to offer more open house programs; to study its budget and determine whether it is possible to have a summer program or to focus only on the school year; and to present a workshop on remote sensing applications and environmental evaluations at the Collaborative's fall 1996 conference at Avery Point.

Talcott Mountain Science Center reported the following statistics on

its museum center program. There were 108 hours of instruction provided by 4 different instructors. A total of 833 students and 39 teachers (equal number of classrooms) participated in the academic year program. They came from 9 different school districts. There were 16 students enrolled in the 1995 summer program and 37 students enrolled in the 1996 summer program. Also, Talcott Mountain Science Center presented 4 telebroadcasts on the following topics: Weather Networking with Dr. Mel, Jason Project in Florida (with The Maritime Center at Norwalk), Saltwater Analysis (with The Discovery Museum, The Maritime Center, and Mystic Marinelife Aquarium), and Keepers of the Earth: Native Americans and Their Influence on the Environment. The center has no exact data regarding who and how many viewers there were. However, museum staff report that many people come up to them at workshops and say that they saw Jonathan Craig and Dr. Snow on the telebroadcasts.

Children's Garbage Museum and Education Center

During the third year of the Collaborative, the objectives of the Children's Garbage Museum are: to provide students with a very intensive 1.5 hour program, including pre and post visit materials that are sent to the schools; to present a movie on the theme that the different schools come for; to provide a laboratory experience on this theme; to set up for students' viewing at least three related exhibits; and to provide students and their teachers with a tour of the facility.

Valerie Knight-DiGangi, of the Children's Garbage Museum, reports that "the teacher's feedback is extremely positive. They would say that their objectives for science and math are met at a high level." The results for the students are also positive. They become aware of the themes, packaging and household hazardous wastes, and take these back to their classrooms for further work. The appeal and utility of the museum were demonstrated nationally this summer in an article, "A Graphic Lesson in Waste: Kids Learn to Cut Down on Trash at Garbage Museum," that was published in *USA Today.*

The only problems experienced by the Garbage Museum are that the children from the Westrocks school were scheduled for a visit twice but

both events had to be canceled, due to heavy snow.

The Museum made some adjustments in its program to make the content more appealing to children. Originally, they had a packaging laboratory, where children studied the difference between packaging for an earth-friendly and not friendly lunch. This was found to be "boring" for the students. In its place, the Valerie Knight-DiGangi substituted a program on making plastic materials. The particular substance is known as "gak," which is a combination of glue, borax, and water. The result looks and feels like silly putty. The object of the lesson is to teach the children how monomers come together to form polymers. According to Ms. Knight-DiGangi, the lesson is a great hit with the children, since they make an unforgettable discovery at the museum and can repeat the experiment in their own homes, including interesting variations with food coloring.

The Garbage Museum plans to add a new theme next year on resource conservation. For this lesson, they will discuss recycling and waste reduction to help the children understand the importance of protecting renewable resources. There will also be discussion of energy conservation in general.

CRRA-Mid-Connecticut Project Visitors Center

The objectives for year three of the CRRA-Mid-Connecticut Visitors Center are: to broaden the science experience for the middle school students and to give the students real life applications.

Cheryl Burke, of the Project Visitors Center, described the 1995-1996 program as "highly successful." She attributes these results to the museum's employment of a professional staff, setting limits on students' behavior, and designating teachers' responsibility while attending the museum with their students. A specially designed kit is available with a curriculum for teachers to take on loan from the museum and conduct lessons for one to two weeks in their classrooms. The Visitors Center usually serves teachers from Hartford and New London.

Concerning student and teacher behavior, other museums in the Collaborative also commented on the tendency for the school visitors to see the museum as a "fun trip" and they would arrive with the

expectation that this is a trip to an amusement park, which it is not. It is important to note that the Children's Garbage Museum and the Visitors Center each serve approximately 15,000 people per year. Hence, they are accustomed to accommodating a wide range of people (school children through senior citizens) and large groups.

Cheryl Burke said that plans for the next year include providing more follow-up activities for teachers to use in their classrooms after the visit to the museum and designing pre and post visit lessons for the teachers.

4. Analysis of Survey Data

This analysis of data is tentative because the data set is incomplete, due to some inconsistency in the administration of the survey instruments. Nonetheless, the instruments that CRE obtained provide interesting results.

1996 Teachers Evaluation

A majority of teachers who participated in this program are female and have masters degrees in science. The group varies in regard to the number of years of full time teaching experience. At least half of these teachers indicate that they had no prior knowledge of Connecticut's Statewide Systemic Initiative, Project CONNSTRUCT.

Concerning the 20 items for evaluation of the program, a majority of teachers expressed high approval ratings for most aspects of the Collaborative. There is evidence of lower-than-average evaluation for the following items

4. Materials and activities are appropriate for my applications.
9. Examples of the integration of math and science were clear, adequate, and varied.
10. The program made me more competent in the use of technology.
11. The program gave me concepts and strategies to decrease emphasis on textbooks.
12. How much has this program contributed to my development of student-oriented activities?

Based on these results, the Collaborative might want to consider exploring with the teachers why they see a possible mismatch between the materials and their students. Also, the Collaborative may want to place more emphasis on integration of math and science, teachers' knowledge and use of technology, and teachers confidence with development of strategies for teaching with less reliance on textbooks.

The following responses are characteristic of teachers' handwritten comments.

1. What was the most professionally rewarding aspect of this program? Why?
"I enjoyed meeting other educators outside of a school environment, and knowing that there are so many other caring adults out there."

2. Did the program itself or any presentation leave you unsatisfied or disappointed? Why?
"Some of the centers did not have adequate pre and post visit materials. Also, there were instances when a particular presentation, whether video or live, was less-than-interesting to the students and teachers."

3. What suggestions can you offer to improve this program, including follow-up activities?
"This program is great, well-organized, and fun. Our team enjoyed participating in the program. We hope the funding continues and we will be included in the future."

4. What are the most important barriers to this educational change in your district? Why?
"It's just time-consuming trying to fit everything in. Getting the students ready for reach museum visit while trying to cover all the required curriculum is difficult." Also, "the number of field trips was disruptive to curriculums outside of math and science. The school-wide perception was that our team was missing a lot of class time."

Generally speaking, the teachers comments present highly positive perceptions of the Collaborative. Data collected during interviews with museum officials and observations of the Collaborative's activities support the teachers' perceptions.

Students' Evaluation Form: Summer 1996

Students' check marks show a strong pattern to support the conclusion that the Collaborative provides an exciting and thoughtful introduction to informal science. In response to Item 3, most students indicated that the museum programs were "not the same as in class." In fact, some students wrote accompanying statements, such as "it was made to be interesting," and "it was a lot more fun here."

All surveys turned in by students were completed. Also, students tended to write fully developed, formal statements in response to questions on scientific processes and facts. For example, one student provided the following statement in answer to the question, What is science? (In about 20 words or less.)

> *"Science is the explanation of natural mysteries. We use the knowledge we find through science to explore further, such as space."*

Students responded similarly with requests for three reasons why science is important. The following are representative examples.

a. It is involved in everything.
b. It's laws explain many things.
c. It is used in many occupations. It's discoveries can help people.

The important scientists most often identified by the students were Sir Isaac Newton, Albert Einstein, Galileo Galilei, and Steven Hawking. In most instances, the students correctly noted the scientists' discoveries. However, no one specified the actual date of a discovery.

Finally, students expressed a very positive overall response to the museum visit. Most indicated that the museum project increased their interest in science and that they were willing to study very hard to improve their knowledge and skill in science. Most checked "maybe" in response to the item that asked if they wanted to become a scientist. Also, most indicated that they had discussed their interest in science with their parents.

Data is not yet available from the other instruments.

5. Main Themes for Year Three

The different museum centers that are partners in the Collaborative have had a positive impact on approximately 850 students and 40 teachers statewide. Also, urban and suburban school districts participate equally in the program.

In the third year of this program, there is a strong *esprit de corps* that is especially evident during the monthly Executive Committee meetings. Everyone wants to make this the best program it can be and there is a shared vision of the idea of museum-based teachers' professional development for informal science education. The Executive Committee members come together to get the work done that needs doing. These key participants take pride in their accomplishments as representative of individual museums and as members of the collaborative. They also are honest regarding the difficulties they face and the program's shortcomings.

Collaboration of different science museums is the key to this program's development. These men and women come together to do the business of coordinating and developing a project that had no prior existence and that, in the past three years, has established its place and proved its value. They solve problems to the mutual benefit of all and in the best interests of the Collaborative. They exist to serve the science education needs of the State's middle school teachers, students, and their school districts. The Collaborative constantly looks ahead and plans for long-term development.

Beyond these more general accomplishments, the Collaborative has been successful in this third year with completion of key products, namely, the curriculum guide and the fall Marine Educator's Conference at Avery Point, CT.

Finally, due to their experience and their tendency to focus on the

future of the Collaborative, these museum officials are developing a workable idea for how to improve the education of the State's science teachers and they have laid the groundwork for its institutionalization in the K-12 schools and university teacher preparation programs. In the process, the Collaborative has become a viable agency for systemic change of science education. It has created a new role for science-rich institutions in the State's system of education and it has put into operation the means by which teachers, students, schools, and communities can improve their knowledge and attitudes towards science.

Issues

A concern of officials at all of the museum centers is that the teachers, in general, express a low level of initiative in the Collaborative's programs. All of the professional development programs museum visits, and laboratory materials are available without cost to the teachers and their schools. Yet, museum officials reported that the teachers do not use the benefits fully. On the whole, teachers do not expend much effort to get seriously involved in the program's development. The explanations museum officials offered for teachers' low-level initiative varied, but usually focus on a low-level commitment from school administrators, too many obligations for teachers at their schools, and a tendency on the part of teachers to see the Collaborative's programs as a field trip to an amusement park rather than a serious journey into informal science education. In the future, the Collaborative may want to consider adding conditions of participation for both teachers and school administrators, so that involvement in the program builds dedication to the professional development of teachers, restructuring of schools, and improves science education

Scheduling continues to be a problem at all of the museum centers. Museum officials note that their institutions ordinarily serve very large numbers of regular customers (tens of thousands annually). This large flow of traffic presents problems with accommodating relatively small groups with the specialized interests of the Collaborative. Nonetheless, each of the centers has found ways to make the schedule work. A related

problem is the relatively low rate of participation by parents. Museum centers are experimenting with different ways to attract and hold the attention of the parents. To address these concerns, the Collaborative may want to stretch the program out from a one year commitment to include a two or three year commitment for students and teachers. This would allow more time in the museum's annual schedules for the intense coverage of science for teachers and students that is required by the program. It would also enable parents (and teachers) to plan their involvement in and expectations of their child's education over a longer period of time.

The high costs for busing students will only increase in the future, due to the ever-escalating costs of fuel and labor. The Collaborative should consider economizing its operations, to have museum centers serve students in the immediate vicinity for most of the program and reserve special funds for trips to museum centers that are remote from the home base.

6. Summary and Conclusions

The Connecticut Museum Collaborative is accomplishing its goals and objectives in a timely and effective manner. The responses of museum officials, teachers, and students indicate a very high rate of approval of its operations and the concept itself. A key to the Collaborative's long-term development is improving the commitments to and investments in the program by all teachers, school administrators, and school districts.

Hence, the main issue of the Collaborative concerns stimulating more widespread commitment and initiative on the part of the schoolteachers and their administrators for teachers to take responsibility for their own professional development and for the development of innovative science curriculum and instruction. The Collaborative is not alone in wrestling with this longstanding problem of the teaching occupation. The issue of teachers' (some, not all) professional development is systemic. The problem arises from an existing but outmoded conception of the schoolteacher who is a person in the community who has done well in grammar school, has satisfied the minimum requirements for college graduation and teacher certification, and whose practice of teaching is best characterized as following a textbook.[3]

In the place of this low-skilled laborer, the Collaborative would put a professional teacher who has a high level mastery of science knowledge and skills and who knows the teaching craft well. Instead of simply mollifying the schoolteacher stereotypes of passivity and low-level academic achievement, the Collaborative would challenge all science teachers to create innovative lessons, design curriculum plans,

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[3]U.S. Department of Education, National Commission on Excellence in Education, *A Nation at Risk* (Washington, D.C.: U.S. Government Printing Office, 1983).

and take an active part in their own professional development and their peers'. To solve this systemic problem, the Collaborative will need to place more emphasis on institutionalization and have more direct involvement with other initiatives in the State, particularly Project CONNSTRUCT.

7. Recommendations

The following recommendations are based on the analysis of data. In many instances, key participants provided these recommendations to the evaluation team.

- Schedule family nights at each museum instead of at one museum. In this way, parents would be free to go to any museum in the Collaborative and exercise the option of traveling short or longer distances
- Continue to improve organizational matters, such as records and documentation, survey distribution, and description of the program. This will add to the efficiency and clarity of the program. It will also facilitate the program's institutionalization.
- Establish a small committee of teachers' who will study the curriculum guide and respond to the survey on its evaluation.
- Consider expanding the number and kind of science centers to include the State's nature centers, fish hatcheries, forest preserves, and historical museums.
- Tap into the Regional Education Service Centers (RESC) for help with outreach to families and communities. Also, consult with the Connecticut Academy for assistance with outreach efforts.
- Concentrate on creating and sustaining building-level effects. Each museum could recruit, organize, and train a cadre of teachers in each school, one school at a time. In subsequent years the Collaborative would keep these teachers and school administrators up-to-date and emphasize their responsibility to other teachers as leaders of curriculum and instruction.

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