Encouraging Young Scientists: Science All Around Us®

A Report to Please Touch Museum® on the Science All Around Us® project funded by the National Science Foundation

PREPARED BY RESEARCH FOR ACTION

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Research for Action is a non-profit organization engaged in educational research and reform. The group's primary methodology is qualitative, case-study research and cross-case data analysis. RFA uses collaborative inquiry processes with educators, students, parents and community members to fulfill its mission of promoting social justice and educational opportunities and outcomes for all students.

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ENCOURAGING YOUNG SCIENTISTS: SCIENCE ALL AROUND US

EXECUTIVE SUMMARY

June 1998

INTRODUCTION

In January, 1995, the National Science Foundation funded Science All Around Us which linked Head Start and day care providers in the Philadelphia, Pennsylvania area, with Please Touch Museum. The funding provided for the development and testing of science and math kits, coupled with professional development for teachers, involvement of parents, and a plan for national dissemination. The project was also to promote increased professional relationships between youth museums and educational settings for three and four year old children.

PTM engaged Research For Action (RFA) as an outside evaluator to provide them with research based recommendations and other data analysis that could inform the project's development. While PTM created and tested materials, curriculum guides, professional development and a variety of events aimed at encouraging family involvement, RFA observed classrooms and professional development sessions, family events, conducted focus groups and interviews with teachers, directors and parents, and administered a survey.* PTM and RFA met together frequently to review recommendations and questions, seek clarification and consider next steps.

This report covers three years of research and evaluation during the development and implementation of Please Touch Museum's (PTM) Science All Around Us project. The project itself and the report structure are introduced in Chapter One. Classroom stories as case studies appear in Chapter Two, with one classroom described in the prologue. These provide windows into the classroom life at the heart of this research and contain much of the data upon which Chapter Three, Findings, Implications and Indications is based. Chapter Three also contains data from other classrooms and sites and quantitative information available from surveys. Family Involvement is described in Chapter Four, and Conclusions

* A Note about The Surveys: Over the course of the project a survey of teacher attitudes and practice was designed. It was administered to teachers entering the project during the second year, but due to major teacher changes and transfers in that year it was impossible to obtain post survey data quantitative data about teachers' behavior and understandings after involvement with the project could not be obtained. RFA instead reviewed of the available survey data. That information has been incorporated as appropriate within the findings.

appear in Chapter Five, followed by an Appendix which includes a calendar of research activities and samples of research protocols..

CLASSROOM STORIES—WINDOWS INTO THE CLASSROOM

The four classroom stories provide windows into the classroom life of teachers participating in Science All Around Us and illustrate the several ways that a range of teachers approached materials and incorporated them into their classrooms. Some teachers who were initially only moderately interested in what the kits might offer became strong supporters of science discovery, exploration and learning in their classrooms. Other teachers who were already committed to bringing more science into their classrooms were pleased with the added focus and materials the kits brought.

The stories make visible the following themes:

- The combination of professional development and kit materials was powerful: Science All Around Us provided new direction, insight, excitement and pleasure in science and math among young children.
- Time was a critical factor: Teachers' understandings and comfort with activities took time to emerge, but over time kit materials strongly influenced and changed what went on in the classrooms.
- Teachers' work was central: Lead teachers and assistant teachers worked together as teams to understand new content and new approaches. Teachers often struggled to balance opportunities for children's science and math discoveries with other classroom expectations.

OUTCOMES, FINDINGS AND IMPLICATIONS

The following questions are addressed in the research findings:

How were science and math materials developed and used?

How did the materials, professional development and classrooms impact on children's learning?

I. Development of Science and Math Materials

New science and math materials had a substantial impact on the classrooms of three and four year old children. Science materials became more visible and accessible. Materials in the Science All Around Us kits proved stimulating and

were the focus for new science activity. Children's books supplied with kits were useful and popular. Balanced teachers guides that offered some ideas and activities to start teachers off, but also left room for teachers to develop activities independently were important.

Implication: *Development and distribution of science and math materials, packaged with appropriate children's books and teachers guides is productive and stimulating to science in young children's classrooms. Teachers' opinions and assessments are valuable for ensuring success of such kits.*

II. Integrating Curriculum

Kits with materials organized into units that fit across the curriculum provided better access and more entry points for teachers than single theme kits piloted earlier. Kits with materials that could be used in several ways or in various areas of the classroom were more extensively used by teachers.

Implication: *The development of kits and projects for early childhood must include understandings of "fit" between the realities of classroom life and the possibilities for early science education.*

III. Professional Development

Professional Development sessions for teachers took on central importance and were crucial to the successful implementation of the project. Professional development gave teachers ideas and increased their awareness of possibilities in science. It alerted teachers to new ways of thinking about active learning and inquiry. Teachers valued as paramount the opportunities afforded them to share experience and efforts with colleagues and strongly urged the museum to set up a network that would allow them to continue this sharing. Staff development workshops that combined both open ended suggestions for exploration and specific activities were most successful.

Most teachers needed time and experience to feel comfortable with both "new" constructivist approaches to science and math, and with unfamiliar materials. Teachers own professional understandings appeared to be a stronger determining factor than school settings. Through professional development and over time, assistant teachers grew stronger and became equally capable, along with lead teachers, of encouraging children's science explorations. Teachers who were interviewed six months after their participation in the project ended expect to continue their increased science focus.

Implication: *Museums and others seeking to devise professional development for teachers must keep in mind that teachers vary greatly in their previous training and understandings, and may need time to integrate major shifts in their perceptions. Teacher networking through study groups can assist teachers in their*

learning process. Assistant teachers are valuable team members and should be recognized and supported for the resources they offer.

IV. <u>Classroom Climate and Tone</u>

Changing classroom discourse and encouraging children's further thought and active discovery required more than a change in the teacher's language and the use of "open questions." If a "technically" open question was voiced, but body language or other teacher signals indicated an expectation of particular answers, children could be confused, not answer at all, or stab for an answer they thought the teacher wanted. `The effectiveness of open questions depended on context of the classroom and often upon teachers' prior understandings. As teachers' knowledge and experience grew, the tone of the classroom often shifted, space and time for science and math in classroom life expanded and invited both teachers' and children's discoveries. Children's visible interest and excitement was reciprocal and further encouraged teachers' commitments.

Implication*: Continued investigation into the many ways that adults can stimulate children's discovery and encourage their curiosity and inquiry is needed.*

V. <u>Children's Learning</u>

Children's activity was the best indicator of what they may have been learning. Children eagerly invented, chose and repeated science activities that they liked.

Implication: *Young children's learning is most possible and visible when they are given opportunities to be active, to experiment and discover, and to play.*

MUSEUM AND SCHOOL RELATIONSHIPS

There is a wide culture gap between museums and schools arising mainly from differences in staffing and core job focus. Building bridges across the two cultures required analysis of the expectations on both sides.

Implication*: In future projects that involve schools and museums, along with museum educators who spend time in project classrooms, an experienced teaching staff position, especially funded and designated as school based, would be useful.*

Family Involvement

Family liaisons were hard to establish with depth or consistency. Over the course of the project, museum educators devised increasingly successful formats for family events, but these affected only a select group of parents who were willing and able to come to the museum. Time and personnel to address the creation of substantial family liaisons was limited.

Family participation in the project was connected to the level of families' participation at the school site in general. However, when there was parent involvement at a site, parents did not seem to be asked to participate in science activities in the classroom. Despite some beginning steps, the majority of parents in the project did not have much involvement with or awareness of science in the classroom. At some sites, however, the project did provide a rallying point to encourage family participation.

Children proved to be the most sustained liaisons to parents. Parents heard and learned from their children about exploratory science activities.

Implication: *Specific resources directed toward the effort of involving parents, such as designating a staff position in this capacity, is indicated in such a project if extensive family involvement is to be realized.*

Conclusions

Science All Around Us kit materials and supporting professional development impacted positively upon children's science learning. Please Touch Museum was rigorous in gathering information from several sources, including Research For Action's recommendations, to enrich their original vision of the Science All Around Us project and to extend the possibilities of young scientists' learning.

Research For Action carried out a formative evaluation research over three years of the project and has reported on that research in this report. Three overarching issues have emerged: First is the time and support required for the integration of new approaches and new knowledge about teaching science to young children; second is the crucial role of teachers as those who ultimately set the tone, plan the activities, and implement the practices the museum develops and advocates; and third is the importance of the museum's professional development that provides the opportunity for teachers to learn together, to share the project developers' insights and suggestions and to develop personal understandings of the possibilities for young children to actively inquire in science.

Prologue—"Almost Illiterate in Science"

It is late spring of 1995. Seventeen three and four year old children in this classroom are mainly Caucasian; a few are African American. The classroom is bright and orderly with neat arrangements of furniture and toys. One long side of the room has open shelving beneath windows that fill the entire space above. The shelves contain games, tins of playdough and craft items, buckets of small blocks and Legos. A line of furniture bisects the room lengthwise acting partly as divider. There is a home center, a library and writing corner, an art activity area and an open gathering space. A small round science table, about twenty inches in diameter, holds what appears to be the extent of existing science materials -- a few magnifying glasses, color paddles, rocks and shells. Science All Around Us kits have not yet been distributed.

Ms. Casey, who has been a lead teacher in Head Start for 9 years, is Caucasian, and the assistant teacher, Ms. Alimon, who is new to teaching, is Filipino. Ms. Casey has very definite expectations of the children, but the tone of the classroom is relaxed and positive. Interaction with students during open activity time consists mainly of encouraging sharing and facilitating material use. Ms. Casey emphasizes to an interviewer her strong endorsement of developmentally appropriate practice. She is concerned about whether the Science All Around Us kits will be developmentally appropriate. (Fieldnotes May, 1995)

In the fall of 1995, the first two Science All Around Us kits have been distributed, and the researcher notes that now, all of the materials from the kits are on the window shelves, replacing the toys which were previously there. "[The kit materials] have a prime visual spot at the children's eye level. ... *the aquarium*[1] contains a beautiful fringed *blue beta fish*, and there are two *insect containers*, one with a (dead) spider which Ms. Alimon, the assistant teacher, had captured." Ms. Casey expresses gratitude for the role that Ms. Alimon always plays when such activities are needed. Ms. Alimon has brought back raw peanuts from Georgia, and they have planted them in four possible *plant mediums*. Children have made predictions about which

[1] Materials from the kits developed under the Science All Around Us Project will be italicized when first mentioned.

medium will allow peanut plants to grow, and the predictions are written on two small charts propped up near the plants.

During the fall research visit, when children are invited to announce their choices for play, no child chooses science, but after the activity time has begun, children wander over to the aquarium to look at the fish, and Ms. Casey calls children over to finish their planting. A child turns the *timer* dial several times and gets it to "ding." Two boys begin to play with the *binoculars*. Another child plays alone with the *sand timer*. Ms. Casey shows the researcher the *children's journals* which she says she keeps available to them in the art area, but little is recorded in them. The researcher notes during this visit that the children seem to see the science equipment as objects of brief interest. She describes the teacher's role during activity time as continuing to facilitate children's access to materials and carrying out maintenance tasks and routines. The notes of that day end as follows:

> Ms. Casey seems personally interested and thoughtful about the science and math materials. But it appears that she has not been able to capture that interest either in language or through her own action to help children think further about them. (Fieldnotes November, 1995)

By spring of 1996, there have been several staff development sessions at the Please Touch Museum, and four kits have been distributed. Ms. Casey speaks enthusiastically about the science in her classroom. She appears to be more aware of the children's activity and the role she could play in encouraging them. She tells a researcher about one of the kits.

> I think that we had the most fun with all the *little bottles* ...We made colored glue. Children loved that, and they like the *squirt bottles* and the eye droppers and putting the food coloring in the water. We also made soft pretzels, but they didn't come out too soft. We overcooked them. They enjoyed that. They made all kinds of shapes. *Modeling clay* ... they really enjoyed that. ... They liked the *goggles*. ... They enjoy the *balance scale* with the bigger buckets. They like the bigger bucket because they can carry it by the handle.
> (Fieldnotes March, 1996)

Toward the end of the school year during another visit, a researcher sees a considerable increase in science activity in the classroom. Ms. Casey uses color paddles with the children and talks with them about what things look like when they hold the paddles up to their eyes. She and the children look at a spider in the insect viewing container and speculate about it together.

A child: "Look, he's moving. (She is shaking the container.) Is he dead or not?"
Ms. Casey: What do you think?
Child: Maybe he is sleepy. ...
"How do you know it is alive?" Ms. Casey asks.
"It is moving," someone replies.
"Let me check that," another child says. Then, "This spider is real."
Another child offers, "This is spinning." (She is referring to a web she sees in the container.)
A child brings over the *tripod magnifier* and says, "Check with this one."
"He is bigger."
"He got his web."

Just following this interaction, another child begins to play with a *slinky toy*. He asks aloud of no one in particular, "How does this go downstairs?" Ms. Casey responds, "What would we need?" When he responds "Stairs," she encourages him to get a set of stairs with three steps on either side that is in the classroom. She encourages him to push the slinky to get it started at the top. Other children gather round asking about what's happening and wanting a try. They are using two slinkies, and Ms. Casey asks, "Why do you think the metal one works better than the plastic one?"
"Too small," and "too pink," are the answers.
"Do you think if it were a different color it would work?" Ms. Casey asks. (Fieldnotes May, 1996)

At the end of the school year, in June 1996, Ms. Casey and Ms. Alimon are interviewed. The researcher notes that, "Ms. Casey is very positive about the influence of the kits and feels they've contributed a lot. She feels they've expanded her awareness and ability to be creative with science. She says, 'I was almost illiterate in science [before the kits].'" Ms. Casey identifies the expanded space she now uses for science. She feels she has always asked open ended questions, so that has not changed. She also acknowledges the strong influence of Ms. Alimon in handling bugs and insects, something Ms. Casey still prefers to avoid.

Ms. Casey also talks about the children in this 1996 interview. Her statements about the children's interests contrast with a previous statement she made in the spring of 1995, when she asserted that she had to change science materials often in order to attract the children. Now, she says, "[The children] are like dying to go to the science area. And we went from a real small area to a large area .... I think they enjoy it more. They're exploring more. And I enjoy it more. I'm learning just like they're learning from it. ... they have their interests more than ever in the science area ... And with having the kits, it really has made us expand."

In December of 1997, after her official time with the project has ended, Ms. Casey is vocal in her responses during a focus group discussion about science in her classroom: " ... now I have science throughout the whole classroom. I put it in all different areas, not just the science area ... The kids love it when I open that trunk [where the science materials are stored]. I always thought of science as, 'What am I going to put there?' But now it's just a lot." Later, as discussion continues, Ms. Casey volunteers, "One day we caught a good size spider, and he started to spin a web, and they came over to the table and drew, without prompting, spiders. ... I was really amazed that the kids went over to draw without being told."

Ms. Casey responds enthusiastically to another question posed during the same discussion: What would teachers say if a visitor came to their classrooms and asked to see how this project is working, how this classroom is different, or what effect the Science All Around Us project has had? Ms. Casey says, "They would see more hands on materials out and available to the children. They wouldn't see this in other classrooms. ... teachers come to my room to get ideas, and when I go to their classes, I see [their children using] things I've had out."

This is the story of a teacher who began the Science All Around Us project somewhat hesitantly. Ms. Casey had been chosen by the Head Start Center leadership in her district. She was seen as a teacher who was experienced and who could assimilate and implement programs readily. But she had her own standards and expectations for classroom materials and usage. She did not embrace everything at once; items from the natural world were particularly challenging. However, Ms. Alimon contributed support and encouragement in that area, and as time and involvement with the project accrued, Ms. Casey became increasingly interested and pleased with what was happening with science in her classroom. She was asking questions and engaging with children and materials in ways she had not previously done. She was *stimulated by the children, who were, in turn, staying longer with science activities, asking more of their own questions, and pursuing investigations. She became much more comfortable, even with spiders!*

While some of the elements in Ms. Casey's story are unique to her own priorities as a teacher, several crop up in the stories of many of the teachers in the Science All Around Us project. Among other things, in the chapters that follow, we will explore some of these common experiences, such as the importance of time in teachers' growing understanding of the Science All Around Us project and the way in which teachers mutually reinforced one another's growth and understanding. We will see how teachers involved generally found themselves increasingly interested in and excited about science, and this excitement tended to spur children's interest in science, producing a reinforcing spiral in which children's new excitement in turn spurred more teacher interest and exploration with science for young children.

Chapter One—Introduction

Structure of the Report

This report began with an Executive Summary followed by a prologue which introduced a classroom that was in various ways representative of the group of classrooms involved in the Science All Around Us project. The body of the report is introduced in this chapter in which the project history and formative evaluation process is outlined. The stories of three other classrooms appear in Chapter Two. They provide windows into the classroom life at the heart of this research. As case studies, the four classroom stories contain much of the data upon which the subsequent chapter containing findings and implications, Chapter Three, is based. Chapter Three also contains data from other classrooms and sites and limited quantitative information available from surveys (*see below*) as well as some indications about issues that can arise in collaborations between museums and schools. Family Involvement is described in Chapter Four. Conclusions appear in Chapter Five, followed by an Appendix.

Background and Chronology

As America faces the twenty first century, science education has captured public interest. The nation's elementary, middle and high schools are giving increased priority to science and mathematics. Science All Around Us, a science and mathematics project for three and four year old children, appropriately encourages a similar focus for very early learners.[2] This report describes the challenges and successes as the Science All Around Us project took shape.

In January 1995, the National Science Foundation (NSF) funded a project that linked Head Start and day care providers in the Philadelphia, Pennsylvania area, with the Please Touch Museum (PTM) also in

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[2] Although originally conceptualized as a project targeted at three and four year old children, in the 1997-1998 school year, Science All Around Us materials were being used in classrooms with children as young as two and as old as six. This expanded use was outside of the scope of RFA's research.

Philadelphia. This project provided for the development and testing of science and math kits, coupled with training for teachers and parents and a plan for national dissemination. NSF also wanted the project to promote increased professional relationships between youth museums and educational settings for three and four year old children.

The Please Touch Museum entered this project with sound experience in early childhood science education. A museum for children ages two through seven and their families, it has developed early childhood science and math resources for its own gallery and has also originated a highly successful set of twenty-three interdisciplinary Traveling Trunks in the arts, humanities and sciences. These Trunks are widely used and praised in local agencies and community groups.

PTM engaged Research for Action (RFA) as outside evaluator for Science All Around Us, to provide PTM with research based recommendations and other data analysis in support of the project. RFA has conducted several museum related educational research studies and drew upon that experience as it developed its research design with PTM. Given the very young age of the children in this project, and an assumption that teaching and learning is a human event with many variables, a qualitative evaluation with a small supporting quantitative component was planned. The research was designed to support inquiry and discussion between RFA team members and museum staff, and included detailed analysis of several research events repeated over time. The research events included: data collection and detailed descriptions of classroom interactions and physical spaces, as well as family workshops and gatherings; interviews and focus groups with teachers, directors, supervisors and parents; written teacher surveys about pedagogic understandings, as well as surveys and discussions with teachers concerning kit materials and curricula. (A Calendar of Research Events appears in *Appendix A*. Examples of Field Guides appear in *Appendix B*. The Survey Instruments appear in *Appendix C*.)

The balance of this introductory chapter will describe the three phases of activity in which PTM and RFA were involved. PTM created and tested materials, curriculum guides, professional development and a variety of events aimed at encouraging family involvement. RFA examined each of these areas of PTM's work, recommended changes and additional actions, raised questions, and provided comments. PTM and RFA met together frequently to review questions, seek clarification and consider next steps.

First Phase of the Project: Formulating Goals and Research Understandings

In early 1995, Research for Action began meeting and talking with the Please Touch Museum project staff, as well as directors, parents and teachers of the Head Start and day care centers partnered with PTM in this project. Understandings from these meetings helped PTM shape the *pilot kits* they began distributing to classrooms in the fall of 1996, and helped RFA frame research questions and pilot early field guides.

PTM planned materials and curricula which would increase science and math awareness, play and learning in classrooms of three and four year old children. Some of their major questions in the early phases of the project were: What kinds of science and math materials would be safe and durable, would encourage play and exploration, would be developmentally appropriate, and would help teachers use a constructivist approach to science? How might kits and teachers guides be organized?

RFA and PTM worked together to address these questions, build understandings of shared goals, and meet the challenge of identifying observable and developmentally appropriate assessments of children's understandings. Formative research, to which PTM and RFA were committed, required that they find common ground upon which to base expectations of their work together. For example, it might have been possible to ask children to perform some small task which would display their knowledge of plant growth or animal behavior, but PTM and RFA recognized that if the project sought to encourage young children's experimentation and discovery, it would hardly be informative to ask three and four year olds to display isolated factual knowledge. The quest for developmentally appropriate evidence of young children's learning led RFA to compose preliminary charts and field guides which assisted the gathering of research data about children's and teachers' activities in classrooms. (These charts appear with the Field Guides in *Appendix B*.)

Throughout the spring of 1995, RFA visited the selected classrooms at each of the five partner sites and using the assessment charts and related field guides, collected baseline data before the Science All Around Us kits were distributed. Analytic summaries of this data were reported to PTM by RFA in memoranda and regular dialogue at monthly meetings, and in a year end report.

Second Phase of the Project: Piloting The Kits and the Research Methodology

During the school year 1995-96, PTM distributed four Science All Around Us kits to teachers in what was designated as Cohort One (*see Chart Ia for Demographic Data on Cohort One)*. These kits, which will be referred to in the text as *pilot kits*, were:[3]

1. TOOL BOX, which contained tools such as balance scales, counting cubes, magnifiers, aquaria, and journals, along with background information and book suggestions for teachers.
2. OUR WORLD, which contained natural science materials such as animal track stamps, planting materials and seeds, samples of tree cross sections, rock samples, and animal photos.
3. MIXTURES AND CHANGES, which contained a variety of liquid and solid materials for making mixtures, plus containers and tools for mixing them.
4. MOVEMENT AND MOTION, which contained physical science materials such as pulleys, ramps, balls, surface covers (e.g. felt, plastic wrap, foil), gears and movement games.

Each kit remained in the classroom for approximately six weeks before being returned to the museum. Kits were accompanied by professional development sessions held at the museum, which were designed by project educators to relate to each kit. Kits also included a teachers guide and several related children's books.

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[3] Additional kits were planned for distribution during the following year, 1996-1997. These included a revised TOOL BOX, WATER EXPLORATIONS, SOUND SCIENCE, and INSECTS AND OTHER CRITTERS.

CLASSROOM SITES
Cohort One started out with 5 classrooms:

- **Three of the classrooms were in public school Head Start centers; 1 classroom was in a Head Start center affiliated with an independent agency; and 1 classroom was in a private day care center.**

TEACHERS
Five lead teachers and four assistant teachers[4] participated in professional development at the museum (9 teachers total):

- **The teachers were racially and ethnically diverse (4 Caucasian, 3 African-American, 2 Asian and 1 Hispanic).[5] All teachers were female.**
- **With the exception of one new teacher, the lead teachers were all experienced-- the four experienced lead teachers had between 10-20 years of teaching experience. The assistant teachers in contrast were new teachers--they had between 1-4 years of teaching experience.**
- **The majority of lead teachers had been in their current positions for some time, indicating stability in staffing at the Centers--three lead teachers had been in their current positions for more than 5 years and a fourth for 14 years.**

As the pilot year continued, focus on PTM's professional development became stronger. Open ended questions were studied and were soon a key aspect of the museum's professional development sessions. Alternative formats for teachers guides were also piloted by PTM. These ranged from brief highly open ended guides, which merely asked questions, to highly structured and detailed guides which suggested numerous activities and possibilities for material use.

Starting at this early stage, RFA and project advisors encouraged PTM to spend time in classrooms in order to see first hand how partnerships between teachers and the museum might be nurtured and facilitated. It seemed clear that both constituencies, museum educators, and teachers, had something to learn from one another, and by the close of this pilot year, the PTM project educator had made some classroom visits and planned more for the following year.

During this same pilot year period, RFA continued work begun the previous spring on evidence of children's learning. The preliminary charts and field guides used to gather early research data led to the development of a hypothesis about children's learning. Young children's learning appears to be circular and spiral rather than linear in nature. This hypothesis led to

[4] The assistant teacher in one of the classrooms was unable to attend the professional development at the museum.
[5] Unlike the rest of the data in this chart, these numbers include the assistant teacher who was unable to attend professional development.

new, more descriptive, field guides which fit the reality of children's activity more accurately than did checklists or small task descriptions. The hypothesis proved a useful tool for data analysis. (An explanation of the Hypothesis of Young Children's Learning appears in *Appendix D.*)

Project goals formulated during this pilot phase helped to guide the data collection and to forge a common language for discussions between RFA and PTM about the research. There was continued strong emphasis on formative evaluation that would help PTM assess its materials and deepen its professional development. Analysis of data collected at sites, during professional development, focus group discussions, and interviews led to recommendations contained in the extensive reports and memoranda written throughout the pilot year by RFA. Meetings, during which questions and recommendations from the reports were jointly considered, contributed to PTM's adjustments and revisions as new kits were sent into classrooms through the year.

Another product of this busy pilot year was a written pre- post-Survey of teachers' attitudes and practice, designed by RFA, which was completed by participating teachers, and a control group of teachers, from the same sites at the beginning of the 1995-96 school year, before kits were distributed and was again administered at the end of the 1995-96 year. Obtaining surveys from the control group proved difficult; despite repeated efforts, only half of the control group teachers returned the surveys. That fact, coupled with the knowledge that materials and ideas from the kit were actually impossible to "contain" in one classroom when another classroom nearby was involved led to the RFA recommendation that the plan for a control group be dropped from the project.

RFA's report, submitted at the end of the pilot year, summarized teachers', parents' and administrators' views of the project. The report documented that all constituencies believed that the kits and related supports had prompted thought about science in classrooms. It also suggested new directions for teachers and children. It was clear that the joint work carried out by PTM and RFA had prepared the ground well for the implementation phase scheduled for 1996-97.

Phase Three: Changes and Consolidations

The school year 1996-97, presented multiple challenges which caused plans to shift. Major personnel changes took place at the museum. The original materials developer and project educator left the museum during the spring and summer of 1996. Two new project educators were hired in the late summer and early fall of 1996.

Another challenge was related to the new group of teachers, scheduled to enter the project in this year, designated as Cohort Two. (*See Chart Ib for Demographic Data on Cohort Two.*) There were major changes at the project's partner sites. Cohort One remained stable, but during the fall and early winter, most of the new group of teachers, Cohort Two, had moved elsewhere and were no longer participants in the project; one site had dropped out of the project entirely. By mid-year, only two of the seven Cohort Two sites had intact teacher teams. At some sites the project continued with substitutes; in other cases new sites were added. At two sites, assistant teachers who remained consistent, were able to carry on.

Cohort Two had been scheduled to receive revised *pilot kits*. These were the *pilot kits* that the first cohort had tried and to which they had responded. PTM had made revisions to these *pilot kits* in response to teachers' and Project Advisors' reactions as well as their own assessments of the kits. However, when the new museum educators reviewed the *pilot kits*, they decided to reorganize them. They wanted Science All Around Us kits to fit more closely with curricula already in place in three and four year old children's classrooms. They organized materials sequentially based upon children's gradually widening developmental understandings. The first kit centered on the individual child, the second on the home, the third on community and the fourth on the world. Each of the original focus areas -- water, vibration, change, natural phenomena, and movement was included in each of the four new kits. These new kits will be referred to in the text as *reorganized kits*. Two of these *reorganized kits* were distributed to Cohort Two during the 1996-1997 school year.[6]

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[6] My Body and Science and My Community ad Science were developed and distributed in the 1996-1997 school year. My Home and Science and My World and Science were developed and distributed in the 1997-1998 school year.

CLASSROOM SITES

Cohort Two started with 8 classrooms:

- Five of the classrooms were in public school Head Start centers; 2 classrooms were in a Head Start center affiliated with an independent agency; and 1 classroom was in a private day care center.

TEACHERS

Eight lead teachers and seven assistant teachers[7] participated in professional development at the museum (15 teachers total):

- The teachers were racially and ethnically diverse (5 African-American, 1 Hispanic and 9 Caucasian teachers). Fourteen teachers were female; 1 teacher was male.
- The majority of the teachers involved were experienced teachers – 7 of the 15 teachers had between 10-28 years of teaching experience; an additional 4 of the 15 had between 5-10 years teaching experience; 4 teachers had less than 5 years of teaching experience.
- There continued to be a differences in the experience levels of lead and assistant teachers: Lead teachers averaged 16 years experience while assistants averaged 7 years (with a range from 1 to 16 years of teaching experience).
- Nine of the 15 teachers had been in their current positions more than 5 years; 13 of the 15 teachers had been in their current positions more than three years, indicating stability in staffing at the Centers.
- Both lead and assistant teachers varied in their educational backgrounds, with lead teachers having on the whole more formal education:

LAST EDUCATIONAL EXPERIENCE	LEAD TEACHERS	ASSISTANT TEACHERS
High School	0	4
Some College	1	2
Attending College	1	1
College Graduate	1	1
Some Graduate Studies	2	0
Graduate Degree	3	0

[7] The assistant teacher in one of the classrooms was unable to attend the professional development at the museum.

CLASSROOM SITES

Cohort Two started with 5 classrooms:

- Three of the classrooms were in public school Head Start centers; 1 classroom was in a Head Start center affiliated with an independent agency; and 1 classroom was in a private day care center.

TEACHERS

Five lead teachers and four assistant teachers[8] participated in professional development at the museum (9 teachers total). Seven teachers (3 lead teachers and 4 assistant teachers) were in the project for the duration of the 1996-1997 school year.

- The group was racially and ethnically diverse (5 African-American, 1 Hispanic and 3 Caucasian teachers). All teachers were female.
- The majority of the teachers involved were experienced teachers – 6 teachers had between 10-20 years of teaching experience; an additional teacher had between 5-10 years teaching experience; 2 teachers had less than 5 years teaching experience.
- There continued to be differences in the experience levels of lead and assistant teachers: Lead teachers averaged 11.2 years experience (though this mean is slightly misleading since one teacher had only one year of teaching experience) while assistants averaged 7.25 years.
- Five of the 9 teachers had been in their current position more than 5 years; 6 of the 9 teachers had been in their current position more than 3 years. These numbers reflect the staff changes in this Cohort.
- Both lead and assistant teachers varied in their educational backgrounds, with lead teachers having on the whole more formal education.

LAST EDUCATIONAL EXPERIENCE	LEAD TEACHERS	ASSISTANT TEACHERS
High School	0	2
Some College	0	1
Attending College	0	0
College Graduate	3[9]	1
Some Graduate Studies	0	0
Graduate Degree	2	0

[8] The assistant teacher in one of the classrooms was unable to attend the professional development at the museum.

[9] One teacher completed her degree during the 1996-1997 school year.

The *reorganized kits* were:

1. MY BODY AND SCIENCE, which included Water Exploration, Body Sounds and Music, Human Growth, Five Senses, and Kinesthetics.
2. MY HOME AND SCIENCE, which included Water in Our Home, Home Sounds and Music, Mixtures and Cooking, House Plants and Gardens, and Simple Machines.
3. MY COMMUNITY AND SCIENCE, which included Water in Our Community, Community Sounds and Music, Weather, Recycling, and Transportation.
4. MY WORLD AND SCIENCE, which included Aquatic Habitats, Nature Sounds and Music, Light and Shadows, Animals, and Animal Movement, and Tracks.

Both kits and partner sites were now significantly changed from original plans. RFA's plans for data collection, had had originally assumed an implementation year with in-depth focus on a select number of Cohort Two teachers, and the revised *pilot kits*. With the new developments, however, PTM needed to know how their *reorganized kits* were working out, and what teachers' responses were to accompanying professional development and family events, so PTM and RFA agreed that additional formative evaluation was required. RFA changed its plans to meet the need for additional formative evaluation and collected data from all available Cohort Two teachers. In addition, with PTM's agreement, RFA collected more data from Cohort One classrooms, which were now also getting redesigned kits.

RFA's analysis of the new data, collected in both Cohort One and Cohort Two classrooms underlined recommendations suggested in the pilot year and also added new insights, especially about the importance of classroom themes, around which all teachers structured their curricula. The emergence of assistant teachers as full partners in classrooms, and the importance of a long term investment of teachers' time and thought about new ideas also became prominent in this year.

A revised pre- post-survey was administered to the newest group of Cohort Two teachers, as planned, in the fall of 1996, but due to the major teacher changes described above, pre- and post-survey quantitative data about teachers' attitudes, behavior and understandings before and after involvement with the project could not be obtained. RFA instead summarized the survey data. That information appears in Chapter Three as part of the Findings and Implications.

Some Overarching Aspects of the Project

Family Involvement

Family involvement was part of the original proposal and was an early commitment of Science All Around Us. PTM consistently made efforts to achieve that involvement. Despite the changes in museum and school staff described above, there was a consistent openness toward RFA's and project advisors' recommendations regarding ways to involve families. During the pilot phase of the project, Family Events at the museum as well as smaller family workshops on site were tried. From 1996-1998, project educators conducted Family Events at the museum and gave free memberships to all families of participating classrooms. Nevertheless, family involvement remained peripheral. Insufficient time and resources within the project were key factors hampering PTM's efforts in this area. As RFA's formal evaluation of the project draws to a close, PTM's continuing development of Science All Around Us includes additional exploration of family involvement strategies, such as backpacks of books and related activities to be sent home with children on a rotating basis.

The Museum and School Relationship

From the start museum educators were positioned at the center of the materials development and professional development aspects of the Science All Around Us project. They were to develop the kits and facilitate teachers' use of the kits in their classrooms. The role of museum educators in this project was extremely ambitious. The project required the educators to keep moving ahead at a fast clip, with little time for reflection or consultation. Multiple demands were made by the tasks of developing, assembling and revising kits with appropriate materials, writing Teachers Guides, planning professional development, attending to marketing questions, and creating programs for family involvement, as noted above.

This research did not devote time to analysis of the complexity of the museum educators' role; however, it became clear that it impacted on schools. Museum educators did not have the ability to spend significant time in schools. RFA has noted that issue with museum staff who have agreed with them that it is an important concern needing attention in future museum-school partnerships.

Chapter Two: Classroom Stories—Windows Into Classrooms

Introducing the Stories

During the course of the project, Research for Action collected data at several sites. Each classroom and each teacher in the study offered valuable research insights about the Science All Around Us project. Data from other classrooms, in addition to those below, will be highlighted in Chapter Three, Findings and Implications. The following three classrooms, as well as the classroom described in the prologue, were chosen for detailed description[10] because they each tell different stories that illuminate the findings which appear in Chapter Three.

These classrooms also represent a range in terms of their location, type of program, teachers' own professional understandings, and student population. Finally, teachers in these classrooms remained in place in their schools throughout the study, and were available for data collection even after their "official" participation in the project had ended.

In the prologue story titled, "*Almost Illiterate in Science*," we saw how Ms. Casey needed time and a level of assurance that the materials were appropriate and met her standards. She gained that assurance as she watched the children use the new science materials, and as she monitored her own reactions, both to the kits themselves and to her initial personal feelings of reluctance about handling certain natural materials.

In the first story in this chapter, *"It's Set Up ... And The Kids Just Carry On,"* the assistant teacher's science interest was the reason the Center director choose this classroom to participate in the project. However, as time went on, both teachers' excitement built, as did that of their children and the center director. Science spread throughout the Center. Even parents, who often could not be present during school hours, appeared to understand more about the classroom's science and math focus. The end of the project did

[10] For those readers interested in visualizing these pre-school classrooms, two "classroom maps" appear in *Appendix E.* The first is a map of the *It's Set Up ... And The Kids Just Carry On* classroom. The second is a map of the *Does He Have a Heart?* classroom.

not signal an ending for this site. Instead, there was an increased commitment to early childhood science education, an expanded space for science activities, and a grant request for funds to buy more science equipment.

In the second classroom story, *"We Don't Worry About Making Mistakes,"* the team of teacher and teacher assistant reinforced one another's science and math efforts. They worked as colleagues to introduce many more activities than they had first thought would emerge from the project. As a result, over time children became visibly engaged and active during scheduled lessons and when there were opportunities for independent explorations of materials.

The third story, *"Does He Have A Heart?",* tells of another team of two teachers, who were committed and anxious to learn, but entered the project with little science background. They shared equal responsibility for teaching science content and, right along with the children, often wondered about what was causing something to occur. Their increasing comfort with the detours and pleasures of science enticed them and also encouraged the children toward further discovery.

In all of the stories, it is possible to trace new direction, insight, excitement and pleasure in science and math, which were not present to the same degree before the Science All Around Us project began. In all of the stories, time is a critical factor. Teachers' understandings and comfort with activities take time to emerge; over time kit materials strongly influence and change what is going on in the classrooms. Teachers' work is another critical element: Teachers worked to understand new content and new approaches; lead teachers and assistant teachers worked together as a team, and several teachers struggled to balance children's science and math discoveries with other classroom expectations.

The Stories

"It's Set Up ... And The Kids Just Carry On"

This classroom presented a special challenge. Previous to the introduction of Science All Around Us, the assistant teacher was already introducing a lot of science content. Would the kits add to what was already happening here? If so, how? The lead teacher originally consented to join the project mainly because she knew her assistant teacher would enjoy it. The classroom also had some unique elements not present at other sites.

- *Children are almost equally balanced across two racial groups, African American and Asian.*
- *Family participation in this classroom is not traditional, due to parents' work schedules, but teachers and the center itself make strong efforts at written and verbal communication.*
- *This is a smaller site where the director's influence is strong. She is able to be more intimate with the center's daily life than are directors of larger programs.*

This is the story of what happened as these challenges and unique qualities came together.

This classroom is in a private Day Care Center, located in an urban community of lower class working families, most of whom are either Asian American or African American. Some are Hispanic. English is a second language for many. It is the only center in this cohort funded by tuition, Department of Public Welfare grants and some foundation grants, and not as part of the Head Start network. The center includes two toddler groups as well as four mixed age groups of thirty children each, housed in large open classrooms; the classrooms are spread across three floors of a six story city building. The center was chosen by the museum for participation in the project partly because it is unique in both its student population and its mixed age structure.

The director is a strong presence in the center's life and the professional lives of its teachers. Unlike centers where directors have responsibilities for twenty or more classes spread throughout several buildings, often with a significant number of families who are transient, this director has a smaller and more stable number of children, families and teachers to stay in touch with, all in one building. She is able to know each family; she actively supports teachers' initiatives and interests financially and through daily informal as well as formal contact. Teachers sense that she knows their work well, and she promotes a spirit of cooperative collaboration. Teachers also see that she is professionally and politically active in community and state affairs on behalf of children, families and day care teachers.

The lead teacher of this classroom, Ms. Daniel, is African American; her assistant, Ms. Gregory, is Caucasian. An African American or Asian assistant, who changed several times during the course of the project, is also present as part of the teaching team, and grandparents from a local program, student teachers and others are often present as volunteers. The class includes thirty children who range in age from three through five years old. The children typically remain in their group for three years. The five year olds have a kindergarten program several days a week in the afternoons while the younger children are resting.

Parents' work schedules keep them from significant participation in the daily life of the classroom, but often they volunteer to go on trips and will come into the room to see an exhibit of children's work or a special project that is sometimes set up. Teachers post information near children's cubbies about daily happenings, send home a monthly calendar and try to keep parents informed as they pick up children at the end of the day. The center tries to translate as much of its literature as possible into Asian for those families who are not English speaking. There are two or three parent conferences and written evaluations per year.

The assistant teacher, Ms. Gregory has a strong science interest and background which motivated the director to invite her and her colleague, Ms. Daniel, to participate in the Science All Around Us project. At first the lead teacher, Ms. Daniel was lukewarm about her involvement, but she recognizes and values Ms. Gregory's science ability and enthusiasm, and was therefore willing to go along.

In May of 1995, during the first RFA site visit, before any kits had been distributed, the researcher notes that the classroom is active and pleasant. "There is a lot of purposeful activity. Children move freely and appear to feel comfortable with one another and the teachers. The tone is relaxed."

Ms. Gregory takes eight younger children into a small circle while Ms. Daniel has the rest of the group in a larger circle. Ms. Gregory invites everyone to share what they did last weekend, and then she shares her story of the horseshoe crabs she saw at the beach. The children choose songs to sing together, then Ms. Gregory reads aloud *The Very Hungry Caterpillar* by Eric Carle. Afterwards she tells the children that they will have caterpillars and butterflies in the classroom. She shows them a container of silkworm eggs and cocoons and says they will raise a butterfly that will spin a cocoon like the ones in the container. At the end of the morning Ms. Gregory again shows the children the container of silkworm eggs. She questions them about what is in the container and what will happen. Some children answer that there are eggs, that they will make a web, a cocoon, and then one child says that after that there will be a moth. (These may be children who had the experience of raising silkworms in this center the previous year. It is a regular spring activity.)

In Ms. Daniel's circle there is also singing and some dance and movement activity. There is a calendar and weather activity, an explicit phonics lesson about the letter M, and an alphabet lesson in which children try to recognize the first letter of their name. Then Ms. Daniel tells the children they will soon water plants. She talks with them about the chicken eggs that they just hatched, and she asks them to remind her when she leaves to bring in mulberry leaves for their silkworms. During activity time there is a water table in use with much conversation and lots of pouring and filling of containers. Other activities include use of paints, table toys, puzzles, large blocks, and a housekeeping area. (Fieldnotes May, 1995)

The teachers are interviewed shortly after this first site visit. They have not yet received the Science All Around Us kits. Ms. Gregory says she wants to see children "more involved with science." She wants to keep science fresh and useful in the classroom and science materials more accessible so that children can take them out and use them. She wants more information about what will work. Ms. Daniel has no questions or comments about the expected science kits, but is vocal in her support of communication with families and in discussing the importance of children's social, early academic and experiential learning. (Interview May, 1995)

The next RFA visit in November 1995, follows distribution of the first two kits. Teachers have made the kit materials accessible to the children and sometimes engage the children briefly as they use them. The open tone of the classroom continues to support children's exploration. The science table has been moved from the science corner at the side of the room into a more central space. It has a box of *rocks,*[11] some cocoons, acorns, *tree sections,*

[11] Materials from the Science All Around Us kits will be italicized when first mentioned.

and a box of pine cones and shells. Children are experimenting and using tools, becoming familiar with their feel and appearance. Sometimes they play scientist by using the tools appropriately. At other times, they transform tools into fantasy objects, such as a camera or a musical instrument.

Tools on the table are *binoculars, a bag of hand magnifiers* and a *tripod magnifier*. Later the *pan balance scale* is set up. This table is well used with children coming and going throughout the RFA visit, some staying as long as ten minutes, others more briefly. Several children return often over the course of the morning. Sometimes they work in pairs or in threes. They do this without any adult supervision. They use the magnifiers to look at rocks and at other items on the table; some hold the magnifiers up close to their eyes and peer around the room or at another person. Sometimes they use the tripod and a hand magnifier together. One child accidentally knocks two hand magnifiers against each other, smiles at the gentle ringing sound produced, and starts to sing *Jingle Bells* softly as she knocks them together a few more times. At one point Ms. Gregory comes to the table, takes a child on her lap, and they explore the magnifiers together quietly.

> The binoculars also are popular. Children appear to like unpacking them from their plastic cases. They look through them in both directions and carry them around, sometimes using them as pretend cameras. A child holds up the binoculars to his eyes and says to two others, "Say cheese."
>
> Once as children are walking around with binoculars, Ms. Daniel stops to ask, "Do I look big or small?"
> Child: Small
> Ms. Daniel: Turn them around. Now do I look big or small?
> Child: Big.
>
> At another point a child is looking through the binoculars at another adult in the room. He says, "I see you." She responds, "Am I smaller or bigger?" the child answers, "Bigger."
>
> Only one child actually tries to balance items on the pan balance scale, though teachers or other adults try to demonstrate it from time to time. (It seems something adults are more interested in than

> children.) Some children put items into one side of the balance and then move it with their hands so that both sides are even. Original play occurs when a child tries to get all of the *small blocks* into the plastic container of the pan balance. She is pouring all of the blocks from one container into another, but the pan balance containers are not big enough, so spillage is a problem. The blocks make a clicking sound as they hit one another. Whenever the blocks spill, the child stops, gathers them from the floor and puts them in the full container by hand. Sometimes she starts the cycle again by putting the last few blocks in the empty container first and then pouring the rest. At one point when the container is full, she looks at the researcher and says, "It's popcorn." She returns to her pouring and says again, "popcorn." She turns to get a magnifying lens and uses it as a spoon to stir her popcorn, saying, "hot." When the researcher moves away from the table, she brings her a tub of blocks and offers some saying again, "popcorn." (Fieldnotes November, 1995)

At a site visit in April 1996, the teachers had forgotten the researchers were coming. The science area is large and now incorporated into the play area. It has posters and stuffed paper figures of animals, *posters of kites*, and an *aquarium* filled with green growing plants. The researcher also sees *gears*, Lego, a water table with many *plastic bottles*, and the tripod magnifier set over a bowl of tadpoles.

During this observation, the children have many science choices available. Later the assistant teacher guides them to think about changes, tells them to observe changes directly, and encourages them to think back and predict ahead. These teacher directions create a framework for the children's scientific thinking. During circle time, Ms. Gregory talks to the children about how the trees are changing and encourages them to make connections to their experiences with trees in parks and to other times of the year. After reading aloud from a book about trees, Ms. Gregory brings over the tadpoles and the tripod magnifier. Again she stresses changes by asking, "Do you remember last week when they were so tiny we could hardly see them? What has happened?" One or two of the children say they have gotten bigger. Ms. Gregory asks them to predict, "Can someone tell me what is going to happen to our tadpoles?" A child responds, "Change." Ms. Gregory elaborates by holding up a book with a frog on the cover and tells the children that the tadpoles will become frogs. The children gather eagerly around the magnifier and peer into the bowl.

In April of 1996, the researchers talk briefly with the teachers and find out that the gears and spinning tops from the current kits have been favorites. The tops have led to real "experimentation" during which the children "learned over time," Ms. Gregory reports. She says that after repeated tries they saw that when the tops were spinning, you could discern colors, and that they could spin both right side up and upside down. The children started to use the *sand timer* to time how long the tops would spin. Even the youngest could spin them. Ms. Daniel is equally enthusiastic about the tops and points out that the children learned how to make tops out of the gears.

At the end of the school year 1995-1996, a researcher interviews the teachers about their first year of experience with the Science All Around Us kits and professional development. Both teachers are enthusiastic and vocal. It is significant that Ms. Daniel is much more interested and involved in the project than she was at first. The teachers say that the project has helped them expand their science curriculum and reorganize their space to make a better place for science. They repeat a theme voiced by many teacher participants: "The children were more interested because teachers were more interested." Ms. Gregory states that they have gotten "a lot of new ideas." Both teachers talk positively about the professional development sessions. They liked the hands on activities such as working with mixtures to make oobleck; they say they feel more comfortable with the science materials and activities, and more conscious of asking children more questions to see "exactly what they think about things."

Ms. Daniel expresses another theme that came up frequently between teachers and assistant teachers, "I have to attribute even more of my curiosity to working with [Ms. Gregory]." She tells about the many ways she has gained knowledge from watching and asking questions of her colleague, and then she says, "...just spending this whole year. And really dealing with the kids. And looking at the guide...and listening to other people helped. ...And now, if I see an insect or something...I'm more likely to pick it up and bring it in. Whereas before I was like, 'I'm not picking that up.' " At the end of the interview the teachers mention the support of their director: "She spent quite a bit of money on the science catalogue that we had, and we were able to order lots of stuff." (Fieldnotes May, 1996)

RFA interviewed the center director shortly thereafter, in May of 1996. She confirmed the positive effects of the project, not only in this classroom but throughout her center. She cited the example of oobleck.

> ...It's everywhere, in everything. But I don't mind. I'm happy to see other teachers picking up on the ideas. Mixtures in general took off throughout the center. Even though they had a lot of baking before, now they do so much more. Every classroom has plastic bottles and bottles of mixtures. You can't throw out a soda bottle. Everyone wants to save them for mixing. (Interview May, 1996)

The director goes on to describe how Ms. Daniel and Ms. Gregory have redesigned their space and says they plan to order a new cabinet for science. They have spent all of their budget money for supplies on science materials.

In February of 1997, a RFA researcher makes a brief visit in Ms. Gregory and Ms. Daniel's classroom. She notes that she is "struck with the enthusiasm they express." In this short visit, the teachers talk about many aspects of the project: the professional development, the musical instruments, and the fish. Ms. Daniel again shows her involvement as she tells of their adventures with the ever growing crayfish.

> I stop first in Ms. Gregory and Ms. Daniel's classroom. They are glad to see me and Ms. Gregory is effusive about the success of the kits. "They have been wonderful for the classroom." She says she has loved the workshops. I ask her what has made them so good, and she says they have gotten lots of specific ideas and handouts, and she has liked the leadership. "I will really miss them." (When they have finished the program this year.) She tells me the center purchased more musical instruments for the class this year as a result of the kits. She is also pleased that they will get one kit to keep.
>
> The children are anxious to show me the *fish*. Then Ms. Daniel comes over to point out the crayfish they isolated from the other fish. "We saw him biting the tails of the others, and we didn't want to see them get eaten." She shows me how big he is in comparison to the other one in the tank. (Fieldnotes January, 1997)

In the fall of 1997, teachers from this first cohort are invited to return to the museum for a reunion lunch and a focus group discussion. RFA and PTM want to know how things are going for them now that their official participation in the pilot project has ended. Teachers are asked their thoughts about science as the 1997-1998 year begins.

> Ms. Gregory: Well, the kits were very visible in our classroom. We really have been using them. Every week we do something different. Our kids have been having a wonderful time with the mirrors and the reflections, and I'm really anxious to purchase another kit.
>
> Ms. Daniel: I think this year science has been easier because of knowledge and information gained from the past two years and maybe even knowledge that I had before that. It's more natural now; it's not as much of a task. It's very easy to plan and incorporate and feel free about it. One of the teachers brought in collards, and there were small green bugs, and we put them in the container and put some stems back in there. Some of them died, but some became caterpillars ... and some went into a cocoon and now we have a cabbage moth ... he's beautiful.

When the group is asked about what they anticipate for the spring and later, Ms. Daniel says:

> "We were working on that area from before the project as it was always an area that needed work. That word [science] always did something to you. You got a blockage. Now we see it all ties into everything. It's all related. ... I continue to grow."

In this discussion, Ms. Daniel is seen expanding her understandings beyond what the kits supply. She has made her own discoveries about the insect world, and she sees herself growing. Later she tells of doing hands on science activities at a parent meeting and feeling that it helps the parents feel more connected to their child's work.

> Ms. Gregory adds, "Now when we take walks, we pay more attention. We're more aware of children's interests. We always stop and point out. The kids are doing it more now. They really notice everything that happens. ... we find out what they are thinking.

In the winter of 1998, a researcher returns to the Day Care Center for a final look at the classroom and a visit with these teachers, who had been so excited and positive during their "reunion" at PTM the previous fall. The researcher describes the classroom as she enters:

> The classroom is fairly bubbling with activity. There are several glass sided tanks containing living animals on tables near the center of the room. Ms. Gregory shows me the anoles and the crickets they are raising to provide food for the anoles. Eight children are in the large, expanded science area using hand lenses, the tripod magnifier, a triangular prism, color paddles, a flashlight and mirrors. They are looking at shells, pine cones, and other natural science artifacts. They are also looking at one another, sometimes holding lenses and paddles up to their eyes as if they were eyeglasses, sometimes finding unique uses for the tripod magnifier, such as a hat or a platform upon which to perch something, which is then viewed with a hand lens or a color paddle. Sometimes children vie for a chance to use a particular item, but they seem to be able to share reasonably well.
>
> At the side of the science area where the floor is bare, several more children are concentrating on spinning tops. There are also lots of photographs of animals and natural objects on a table, and children periodically pick these up and examine them. All of the children are calling out to one another, either exclaiming at what they see, "Everything outside is blue! It's summer!" or directing one another to something of interest. "Look at this! This cool, right?" Two girls are discussing a hermit crab shell which has been hinged with button thread (perhaps to keep it from falling apart?). "Look. These are not teeth," says one girl, pointing to the ridges at the end of the shell.

Later in the morning several containers of bubble liquid are set out on a large table along with many small plastic bubble wands. There is obvious pleasure among children, teachers and assistants as the bubbles float about and are examined in the sunlight and exclaimed over. Children come and go, some staying for a long while, others "just passing by."

The Center director has told the researcher about the grant Ms. Gregory has written, which was recently funded. Ms. Gregory asked for funds to purchase additional science kits. (PTM left some kits with the classrooms, but they were unable to leave all of them.) Ms. Gregory wrote about Science All Around Us:

> This experience has brought wonderful hands on science activities involving water, sound, mixtures and changes, puppets and books. In addition we were able to review some books that helped with using the kits. These kits and the staff training that accompanied them have been wonderful for our program. ... Our children loved all the theme kits and were eager to use the materials ... the Music and Sound theme kit ... was a favorite ...

Before leaving the Center that day, the researcher speaks with the director, asking about changes she might have seen over the three years since their center first became involved with the Science All Around Us project. The director responds that she sees "more of a team approach, where before it was more one teacher's individual interest." She goes on to say:

> I see science in more areas of the classroom. It's not an isolated corner, but it's integrated into the curriculum. ... I see that science and art are related. [I see] connecting music to science. PTM channeled thinking, challenged thinking in the classroom about science. I see very little teacher intervention. It's set up, and the kids just carry on. ... If you create an atmosphere where kids can experiment and try things out, it's exciting. Kids discover the enjoyment "[And parents are] more responsive to us. We have less and less worry about getting dirty, or about lizards or crickets. Parents are excited too." (Fieldnotes and Interview January, 1998)

It is clear that as it evolved, the Science All around Us project engaged and stimulated both of the classroom teachers. Ms. Gregory, already knowledgeable and committed to science for young children, was encouraged to move forward with her interest, to learn more, and to trust children to experiment and play freely with a wider range of kit materials and natural artifacts. By choosing to write a grant which would purchase more good quality science material, Ms. Gregory illustrates how important she thinks these specially selected materials are as a motivating force in the classroom. Working side by side with Ms. Gregory, Ms. Daniel discovered a pleasure and comfort with science she had not expected to find, and she too trusted that children would learn through discovery and experimentation. As time went on and science became a stronger focus in the classroom, director, teachers, children and parents were more clearly united as a team, positively influencing one another. The director's support and pleasure in the influence of the project throughout the Center was another motivation for the project's success. It also appears that, even after direct contact with the museum ended, this classroom continues its interest and pursuits of science opportunities.

"We Don't Worry About Making Mistakes"

This is the story of a teaching team that gained confidence in their ability to experiment with science. It is a story about the time it takes for teachers to develop an understanding, appreciation and attitude toward science that encourages children's scientific discovery. As they became more comfortable, these two teachers offered the children in their classroom more opportunities to play with materials, engage in activities and make discoveries about the scientific world around them. It became a classroom in which researchers were able to focus on young children's learning.

This public school Head Start classroom is located in a large, urban elementary school. The school is an older building that melds in with the two-story row houses of a formerly industrial, working class neighborhood. Like the neighborhood, the school is increasingly a demographically heterogeneous community.

The supervisor of this Head Start program began the project hoping participation would give her teachers the materials to capitalize on children's natural interest in science: "Children love science, and anything that can give them science experiences, learning by doing will be a plus" (Interview April, 1995). Ms. Chiu was chosen from among the center's teachers when she and Ms. Marks expressed an interest and willingness to participate in the project and take on the extra work it involved.

Ms. Chiu, an Asian American teacher, had been with the school district for sixteen years when she began the project in 1995. She had been at this site since 1991. Ms. Marks, the African American teacher assistant, had volunteered with the program since 1986, having been a Head Start parent herself for many years.

Ms. Chiu and Ms. Marks' class consists of 3, 4 and 5 year-old children. Generally, students stay for only one year. Although there is a waiting list to get into this Head Start program, parents do not frequently volunteer in the classroom, as required by Head Start guidelines. Neither the teachers nor their supervisor fully comprehends why this is so. If there are special needs children, the classroom is eligible for a Parent Scholar. Over the two years in which RFA visited, it has had a Parent Scholar.

In the spring of 1995, during Research for Action's first visit to the classroom (before teachers had received kit materials or professional development at the Please Touch Museum), the two teachers explain that they try to focus on children's social and educational development. They want children to learn to deal with a group situation, to gain independence, to think about the actions they are taking, to feel good, to be happy and to enjoy school. Ms. Chiu believes it is important to expose children to language and to listen to them. Having varied materials and a large selection of materials is also important. Children should learn to follow rules although "there is no set way to play. Children can explore." (Interview May, 1995)

During this first visit, the classroom is clean and bright. Children's work is carefully displayed in the hallway. Outside the classroom there are notices for parents on a bulletin board. The classroom walls have children's work as well as teacher materials. The room is full of materials for children, all located in easy to reach plastic bins or in baskets on low bookshelves and cubbies. All the shelves have labels: puzzles, library, animals, blocks etc. A sheet of paper is posted in each area, telling the value of children's play in that area.

The tone of the classroom is busy and purposeful. Both teachers interact frequently and speak positively with the children. Children are encouraged to talk with one another, especially if there is a conflict or disagreement. During the early, open activity time, Ms. Chiu interacts with a child who is putting rubber bands on a Geoboard. He shows Ms. Chiu his work.

> She asks: "What shape is that?" There is no response. She asks again: "What is that shape you made?" The child is looking at the Geoboard.
> Ms. Chiu prompts: "A rrr... ."
> Child: "Triangle."
> Ms. Chiu: "A rectangle. Good!"
> Another child picks up an attribute shape on the table and says, "This is a triangle." Ms. Chiu: "Yes. Right. Look, Jane is showing you a triangle. Good."
> (Fieldnotes May, 1995)

Ms. Chiu frequently asks children for information about number, shape, what comes next, what should be happening. This emphasis on quantifying, prediction, similarity and difference continues during the circle time in which there is a calendar and number line activity, followed by reading and nursery rhymes. During activity time each child is called upon to make a wind sock. Meanwhile, the others play at the water and sand tables, in the housekeeping area or work at the computer. Ms. Chiu and Ms. Marks ask many questions about number and color. Throughout they are busily engaging, questioning and encouraging children with materials.

In the fall of 1995, after two kits have been distributed, Research for Action visits the classroom again. The classroom arrangement has been changed although the same materials and general areas are available. Near the window, the cabinet and book rack have been replaced with *an aquarium with fish* and a *terrarium with chameleons*. There is also a small terrarium with crickets (for the chameleon's food). Further down the wall is a table covered with the *green display cloth* from the kit. Under the table are the two kits themselves, and next to the table is the *tripod magnifier*.

On the science table, there is: a tray with *petri-dishes* in which there is a leaf, an insect, some *seeds*, some feathers; five *insect observation containers*--one with the *plastic spider* and one with a yellow jacket; a glass mayonnaise jar with about half an inch of soil and two grubs--one white and one brown; several *magnifiers*; a kaleidoscope; three shells; two chestnuts; and a horse chestnut.

In the center of the room on top of shelves containing puzzles and table toys, there are some other materials from the kit: Two *balance scales* with the *green cubes* next to them in a basket; *rocks* in a plastic container; *tree wedges* on a tray; *binoculars*; *magnifiers*; and a Fisher Price camera in another basket. No one approaches or looks at these materials during the entire time of the visit although they are in the center of the room and lots of activity goes on in their vicinity.

During activity time, the children are busy and lively. They move freely from one area to another--although there is one group that remains determinedly in the housekeeping area, chatting, using all the props and costumes, negotiating for roles and materials. The sand table is also busy, with quieter more soothing play and less language. Science activities, however, are a less prominent focus of children's play as seen in the researcher's comments below.

> I sit for ten minutes near the window area where I can see the science materials on the shelf, but no one approaches them. Then a girl, Carla, comes over to the science table and briefly touches a shell or two and the magnifier.
>
> She is about to walk away when I ask her, "What's here?" She proceeds then to point to a few articles and to say, "this comes from here," indicating the science kits under the table. I ask her what the kits are, and she points to the footprints on the label of the Our World kit and says, "footprints." I ask her what the tripod magnifier is, and she responds, "to look at things with." Carla then proceeds to point to each item on the table and say, "This is from here. ... This is from here," pointing to an object and then to either the Tool Box or the Our World kit.
>
> As she points to the acorn, I ask her to tell me about that, and she says, "acorn." I get the same one word response, "bumblebee," when I ask if she can tell me something about that item in the petri dish. Then, she continues identifying which items are from which kit again--with great speed. Finally, she says, "I finished." I wait thinking she will say something more, but she repeats somewhat more loudly, "I finished," and walks away.
>
> A few minutes later, Carla comes back and asks if I will help her feed the fish. I tell her she has to ask her teacher if it is okay. At that moment, Ms. Chiu comes over and asks Carla what she wants. Ms. Chiu agrees to help her feed the fish. As Carla drops the food into the tank, she is visibly excited to see the fish eating. Ms Chiu asks her, "What are the fish doing?" She responds, "Eating." Ms. Chiu continues to ask several questions. "Now where are they?" Carla: "At the top [of the tank]." "And where is this one?" "Bottom" Carla points and smiles. For a brief moment, Ms. Chiu is quiet and smiles as she watches the fish with the child. "They're hungry," says Ms. Chiu. And in a moment, she asks Carla, "Did they have enough?" Carla responds, "yes." (Fieldnotes November, 1995)

The two proceed to feed the chameleons. Both are greatly excited to see the chameleons pounce on the crickets and clamp them into their mouths. Ms.

Chiu asks several questions about what they are seeing. Carla often gives back the one word answers Ms. Chiu seeks. After Ms. Chiu leaves the area, Carla remains watching the chameleons. "I feed them [pointing]," she confides to the researcher. "That one's Tifah," she says pointing to the chameleon's name written on the terrarium, "and that one's Mickey," indicating the other name written out.

The day ends with a teacher led activity in which the children take turns identifying items inside the *touch and feel bag*. The items are from the two kits. Each child is asked to name the item they get.

By the end of their first year in the Science All Around Us kit project, Ms. Chiu and Ms. Marks indicate that they are feeling more aware of the broader context of science. Their vision of the boundaries of science has been expanded.

> Ms. Marks: [Science is] more in us now. I feel like it's just a part of us now.
> Ms. Chiu: We orient ourselves more to the science sessions and science observations. Where we might have observed before, we really didn't tie it into science. We're looking out more for science today. Things to point out to children. (Interview May, 1996)

The following winter, 1997, this new stance toward science solidifies as involvement in the project continues. At an interview Ms. Chiu and Ms. Marks reflect on their continued professional growth in the project:

> When asked how they feel about science this year as compared to last, Ms. Chiu responds, "We feel like pros." They "feel so comfortable." "We're not as threatened, not as hesitant to try new things," Ms. Chiu continues. Ms. Marks adds that because they are more comfortable, they've felt free to try more things and be more relaxed about experiments that failed, for example, raising frogs. (Interview February, 1997)

This increased awareness and comfort is evident in the abundance of science related materials easily accessible to the children as well as in the ever growing animal life of the classroom. That same day, a researcher writes.

> Entering the classroom, I immediately notice a water table which is filled with colored pasta, painted pasta shells, beans, cups, *sieves*, *measuring cups*, boats, shovels, *funnels*, bottles, and the like. At one of the lunch tables, the musical instruments from the Sound Science kit are out: *metal slinky, drum brushes, mallets, rainsticks, finger cymbals, triangle, maracas, pie tins, wooden spoons*, and *wooden dowels*. A box with the rest of the instruments rests on the table. (During the interview, Ms. Chiu and Ms. Marks tell us that they play the *tape* from the kit to the children often.)
>
> There is documentation of recent activities around the room, including hand prints on the wall and a write up of a nutrition activity--"James: Corn Quiet etc." Two food sounds are mentioned, crunchy or quiet.
>
> In the science area, there is a sand table in which there are *sieves*, buckets, several bottles, cups, *funnels*, and shovels. I am immediately drawn to *the fish tank*, near by. It is brightly lit with pink rocks and marbles on its floor and a pink marble column. Eight *fish* of various species swim around. Another tank along the window is shared by a garden snake and two chameleons. This tank is full of vegetation and looks very alive and wet. In still another tank there are snails, silkworms, crickets, hermit crabs and decomposing fruit--some of which is food for the other creatures. The science table is also filled with various natural objects (snakeskin, moths, starfish and shells) and tools (*magnifiers, magnifying boxes, spectrum viewers*). (Fieldnotes February, 1997)

Over the course of visits to this classroom in the winter and spring of 1997, the increased comfort and open attitude of Ms. Chiu and Ms. Marks is seen by researchers who note how this affect is leading to more science activities, both during free play and during teacher-directed activity time. Open exploration of science materials has become a mainstay. After an activity packed morning that includes a group activity involving comparisons of the sizes of the children's hands and feet and the smells of different extracts, followed by an animated drawing activity using the smelling markers, the researcher observes:

> Right before the end of free time after completing their drawings, Lisa and John bring out a whole bunch of magnets (horse-shoe, paddle,

> etc.) and iron pieces to play with. It is very clear that Lisa has learned much about magnets. She places a small metal piece on top of the table and then places the horse-shoe magnet underneath the table, using it to make the metal piece move while teasing, "I'm not moving it." John tries to copy her using the paddle magnet but is less successful. Ms. Barkley [the Parent Scholar at the center] is interested and comes over. She starts to fiddle with the magnets as well, using the paddle magnet to pick up metal balls from a container. Soon, Ricky comes over with some tops. He spins a couple and then places a paddle magnet in a cup of smaller magnets. They repulse. He leaves it there and goes on to other things. Lisa soon picks up the paddle magnet he's just left in the container. The small magnets flip. Then, she starts picking up the metal balls in a string, one by one. The last thing I notice before clean up is John showing Lisa how he's managed to attach two magnets on either side of a plastic container lid. Throughout John and Lisa have been playing together, mostly with Lisa leading. (Fieldnotes April, 1997)

At a later visit to this classroom, a similar moment of child-initiated and directed exploration is observed. The water table has been filled with soapy water. Fatimah and Ms. Barkley, the Parent Scholar, try to fill a cup with water from the table using a turkey baster and a clear tube.

> Ms. Barkley makes a first attempt and hands the baster over to Fatimah. Many minutes pass as Fatimah tries, without success, to accomplish the same task. Ms. Barkley holds the tube for Fatimah. The water won't rise above its level on the other side of the tube. This is like watching Sisyphus roll the rock up the mountain. Ms. Barkley is distracted through much of this as she attends to the needs of other children in the room. Suddenly it starts to work although the U-shape of the tube never disappears. Ms. Barkley then refocuses her attention on Fatimah, and the two proceed to work together to fill the cup. Meanwhile, the rest of the children are pretending to wash dishes. (Fieldnotes May, 1997)

Another morning observation begins with Ms. Chiu and Richard's feeding of the class' burgeoning animal kingdom. Ms. Chiu informs Richard that it is his turn to feed the animals, and he happily assists with the routine.

> Ms. Chiu asks him to get the food, and then asks, "What kind of food is it?"
> He answers, "Food." She tells him it's fish food and has him repeat it. She measures it out and gives him the food to put into the tank. As the fish eat, Ms. Chiu asks Richard if he thinks they are hungry. He says yes, and she asks him why. He points to them going toward the food. Ms. Chiu also asks Richard if they are going up in the tank or down in the tank to get the food. He says, "up." (Fieldnotes April, 1997)

Then they spray water in the chameleon and snake's cage. Ms. Chiu captures the crickets from another cage she has asked Richard to open, and puts them in with the snake and chameleon, then they move to spray the snails and hermit crabs and to put some vegetables in their cages. Other children watch casually, and Ms. Chiu encourages them to notice the food, the shells, and other aspects of the animals' environment. The researcher reflects:

> Lots of questions are asked by the teachers, many of which are open. There is also a relaxed feeling when the questions are asked, that any answer a child gives is fine. This is an interesting contrast to how I saw Ms. Chiu feeding the animals last year. She seems more relaxed, encourages other children to notice the feeding time, and lets Richard do more. And in addition to her question about what direction the fish are swimming, up or down, she has added the open questions, "Do you think they are hungry?" and "Why do you think so?" (Fieldnotes April, 1997)

This same day, when clean up time is finished, each of the teachers begins a small group science project with one half of the children. Ms. Marks leads one of the activities. As in the above interaction between Ms. Chiu and Richard, Ms. Marks encourages the children to discover by giving them the opportunity to play and by encouraging them with a range of questions. She begins by gathering the children around the table.

> She says, "What do you think we're going to do?" I cannot hear their answers. Then she says, "Look at the boxes." Children begin to name what is on the boxes "Corn," says one. "Cheesecake," says another. Ms. Marks says, "Let's look. Pass the box around." They do and peer inside. Then she says, "Want to feel it? Go ahead, you can put your

hand in." They do this also and are pleased to feel the powdery contents of the box. Ms. Marks asks, "Want to taste it? You can put a tiny bit on your tongue." They all do this and seem pleased.

Ms. Marks then asks, "How does it feel?" The children respond "soft," "powder." They smile and laugh. Some get a lot on their hands. She tells them it's cornstarch. Ms. Marks has a second box of cornstarch, and she helps children each pour some into a large bowl. Ms. Marks decides they need aprons as it's getting messy. She asks if they remember what it's called, and a few say, "Corn flour." Ms. Marks says, "Cornstarch." She gives the children food coloring and lets each child put a few drops of a color they choose into the cornstarch in the bowl, and then they stir the cornstarch.

The children take turns squirting water into the bowl and soon try counting the number of squirts each does, but still there is no evidence of color in the mixture despite Ms. Marks's continual stirring. She asks the children often, "What's happening?" Then she gives the children turns to stir. She asks each as s/he is stirring, , "Is it easy to stir?" Some say no, it's hard, others don't answer. (It is clearly quite stiff.) Ms. Marks asks, "When we first touched it how did it feel?" Some children respond, "Soft."

Suddenly the color appears. (Apparently enough water has been added.) The children get excited, "OOOh, look!" Ms. Marks keeps mixing and then spoons some into each child's hand. She tells them, "There's a name for what we're making. It's called oobleck." Then she asks, "What's happening to it? Does it still feel the same as the cornstarch did?" A boys says, "It look like glob." She encourages them to let it rest in their hands and notice what happens.

The children continue to handle the oobleck and to watch it change shape and consistency. Ms. Marks reviews, "What is it called?" "What did we use?" They say corn. She asks, corn what? Ms. Marks sees that they aren't interested in this line of questions and says, "Oh well, just go ahead and play." (Fieldnotes April, 1997)

In this observation, Ms. Marks allows the children to follow their own ideas and to try things out. She asks questions that encourage them to use their senses and their powers of observation as they work. She encourages their awareness of the changes taking place in the material they are handling, and she is genuinely excited by and interested in the children's play. Her playful engagement fosters that of the children.

In an interview with the teachers, they confirm the importance of having had enough time in the Science All Around Us program to become comfortable with the kits. They speak of their increased ability to enlarge the repertory of their classroom discourse and their ability to ask open questions.

> Ms. Chiu and Ms. Marks both feel they are now more into exploring. They are more comfortable letting the kids experiment. They don't get excited if things go off track. They give an example of letting kids be more experimental with cornstarch. It didn't have to be measured so exactly. This is also true of the bean sprouting. When the container from the kit came apart, they just switched the sprouts into jars. "We take things more in stride." "“We Don’t Worry About Making Mistakes”."
>
> ... "We're not as paranoid as we used to be. If something breaks it's okay. We just sit back and laugh at what they're doing." Ms. Chiu says she is not as closed in her thinking of the right way to use something. "I find my thinking has changed" ... "I'm more accepting of their responses. If it smells like bubble gum to a child, I don't correct him and say, 'no, it's really something else.'" She accepts it and says, "It smells like bubble gum to Richard." (Interview April, 1997)

In the Spring of 1997 at a focus group, Ms. Chiu again describes what has influenced them: “Experience, I think. Hands on experience, just like the kids. ... because we actually got in and played with all the stuff [at the PTM professional development], because they [PTM] had materials on hand. It’s just having exposure and experience.”

In December of 1997 at a reunion focus group, six months after formal involvement with the museum has ended, Ms. Chiu and Ms. Marks continue to express their growing comfort with science.

Ms. Chiu: I feel science fell in, and it was a relaxed atmosphere. We have more confidence. The animals are all back, and the kids love them. Our heightened awareness and our responses to them are more science related.

Ms. Marks adds: It was just part of us now. Finding a place for the science table was just part of everything else. (Fieldnotes December, 1997)

In a discussion among teachers in this first cohort, teachers talk about the desirability of finding some way to keep up the collegial network they had gained during the two years of the project. Ms. Chiu cautions, "I hope you'll still be hearing about this in five years."

In the spring of 1998, a researcher visits this classroom for a final look. The classroom is busy and colorful as usual. Around the room there is evidence of the class's recent visit to a Sea Aquarium: on chart paper the teachers have documented each students' favorite sea animal; in addition, the children have drawn sea animals which are hanging on one of the classroom walls. The science table, with its many artifacts, sits on one side of the room, but none of the children approach it during this visit.

This morning the children, in groups of three and four, are taking turns squeezing orange juice with Ms. Chiu. Ms. Chiu encourages them to observe the orange, to think about how they are going to get the juice out of the orange, what the steps of that process are, what the press is doing to the orange, what's coming out of the orange, and how the orange juice tastes. The children meanwhile are engrossed in the textures and tastes. They seem to relish the opportunity to "squish" the orange, drink the juice, eat the rind, and generally make a mess of stickiness around them.

Today's activity is part of a tasting project in which each child has been given a Tasting Passport and the opportunity to taste numerous foods over the course of the year, including among other things honeydew, butter, pumpkin seeds, cranberry sauce, and pudding. After each tasting experience the children are given a stamp in their passports. (Fieldnotes March, 1998)

The focus on the tasting passport is apparently part of a larger focus on the five senses. Ms. Chiu and Ms. Marks have also created a "smell box." In it, there are many different small empty containers of shampoo, cream rinse, shaving lotion, hand cream and other cosmetic products. These bottles, to varying degrees, retain the scent of what once was in them. Throughout the visit, the box is the object of competing interests. One child who finds himself lucky enough to have the opportunity to play with the box engages the researcher in 20 minutes or so of "smell this ... smell this ... do you like this smell?"

At the end of the visit, Ms. Chiu explains to the researcher that this year, she and Ms. Marks have been trying to "blend the science in. We don't make such a big deal" of science as science. Instead, we try to incorporate it into the other activities of the classroom.

In this story we see how time is an important element as teachers work to change the language and context of questions in their classroom. Further, we see that these two teachers' emerging vision of science has resulted in more opportunities for children to interact with materials. In the final visit, each child is given the opportunity to indulge their senses in the ways in which only young children can.

This story also carries a shadow of complexity and question. Though the teachers' ever growing science interest, and children's increased learning experiences are evident throughout, focus group comments about teachers' desires for continued support from outside partners or like-minded colleagues, linked with Ms. Chiu's question about how things will look in five years are notable. Is there any significance in what is observed in the final visit? Although an overall science theme is evident in projects involving the senses over extended time, during this one visit few children are seen initiating independent experiments. This contrasts with observations during the height of the project when teachers were attending professional development sessions at the museum on a regular basis. Then, children were consistently seen carrying out experiments of their own design. In the story, we saw Lisa and John trying to figure out how magnets act. Lisa can predict what might happen, and John learns by watching her process. Then Lisa tries a new experiment by herself. They are behaving like true scientists. We also observed Fatimah who experiments until her efforts suddenly pay off. The water rises and as this happens, she captures the attention of the Parent Scholar, who then continues to work with her. Without the opportunity for further research, it is hard to determine whether there is any importance to the absence of such independent scientific exploration in the final observation.

"Does He Have A Heart?"

This classroom is in the second group of trial sites for the Science All Around Us project and, because of changes described in the introduction, it is the only one from this second group that remained in the project for two years. This is the story of two teachers who were attracted to the project but began with little knowledge or understanding of how they might implement it in their classroom. These teachers are a close knit team. With time, they came to thoroughly enjoy the kits and the professional development sessions associated with the project, and through them, began to integrate more options for science process and content for young children. They were especially engaged with figuring out how to ask the kinds of *questions that would encourage more creative thinking and learning experiences. Time was a key factor in their evolution as science teachers and in their eventual comfort with the necessary detours involved. As time went on, their comfort level grew, and their ability to do new things in new ways increased significantly.*

This classroom is located in a Head Start Center, which is part of a network of "parent-child" facilities under a central administration. The Center and its playground are nestled along a block of newly constructed, inviting row homes in the midst of an inner city neighborhood which, in striking contrast, has many run down and abandoned buildings. A bright mural on the front wall and a handsome gate and walkway lead to the center's front entrance. The entry lobby is welcoming and light with a parent bulletin board announcing such items as community meetings, voting information, fund raising events and calendars. The clean, scrubbed building has three floors housing four Head Start classrooms for three and four year old children as well as a large kitchen, in which all the lunches and snacks are prepared, and a parents' lounge.

Parents are clearly important and welcome in the center, as are other adults who are on the central administration staff, and come to classrooms to offer social and medical services. Parents sometimes stay for a bit in classrooms when they bring their children; they help out when they can. The center director, who is African American, is supportive of the center's mission of working with parents and children together, and is especially supportive and pleased about the Science All Around us project. She sees it as filling a need for which their center previously had insufficient resources.

Most of the seventeen students in this classroom are Latino; a few are African American. The staff reflects the racial composition of the students, with the lead teacher, Ms Johnston, African American, and the assistant teacher, Ms. Rivera, Puerto Rican and bilingual. Adult volunteers are consistently present. Ms. Nolan, the volunteer most frequently present when researchers visited, is African American, a great aunt of one of the children. The classroom holds a monthly parents breakfast meeting. Teachers frequently remind parents of the meetings in person and with posters and encourage them to attend; the lead teacher regularly fills parents in on meetings they have missed. Usually about five to eight parents attend each month's meeting.

In November of 1996, at the time of Research For Action's initial visit, the first science kit has been distributed. The small, bright classroom is neatly set up with areas for home play, blocks, art, books, and a rug area for meetings and quiet games. A round table and some shelving are in one corner of the room, designated as the science area, and artfully arranged with a construction paper tree decorating the wall. Actual tree branches and leaves have been pasted on the wall as well as cut out magazine pictures of monkeys, birds and frogs, which reflect the class's Rain Forest theme. Teachers plan to change the appearance of the tree throughout the year to reflect the seasons and their classroom themes. A shelf unit holds *balance scales, rope,* some *green cubes* and *magnifying lenses*, two unopened *ant farms*, and several of the *science books*, all from the first Science All Around Us kit. Other materials about dinosaurs, a set of Rain Forest sponges, a Rain Forest puzzle, and plastic insects are also on the shelf. Plants, plant shoots in water, gourds, and *children's science journals* are also visible as are an *animal lotto game* and a Spanish language book about animals.

All areas are labeled in both English and Spanish, and much of what teachers communicate to the children is translated into Spanish. The walls contain mainly teacher made or commercially produced displays, with a small number of children's creations mixed in. Later in the year some children's work is hung from small lines strung from the ceiling. The researcher notes, "... this [balance of children's work and teacher's posters] was sort of indicative of the classroom aura as a whole, pleasant and relaxing/mellow [but] controlled by teachers ... . The classroom is later described as relaxed with no sense of rushing children. "[The teachers] seem to let the kids get where they need to be at their own pace."

A chart with questions about string beans, apparently a lesson that had taken place, is on the easel near the science area.

String Beans:
1. What color are they? Green
2. What does it taste like? David - good and yummy
3. Is it soft or hard? Soft
4. Name something else that is green. The ant farm, the plant
5. What's inside? Are they seeds or beans? We snapped the beans.
(Fieldnotes November, 1996)

The questions on the chart paper reflect the efforts teachers in this classroom are making to ask questions that will help children think about an experience. The center participates in a High Scope model that encourages the expectation: Plan, Do, Review. Both teachers try to ask questions that allow for individual responses, but often the questions limit a child's choice of answer by suggesting an either/or response or by focusing on one sensory realm. As researchers continue classroom data collection, teachers are engaged with the issue of questions, in particular, how to ask them and what kind of language is "open," as encouraged at museum professional development sessions.

When a researcher visits the following January, 1997, she notes that the paper tree adorning the science area now has snowflakes on it, and its brown construction paper trunk is dotted with white paint. Posters and a fireplace of construction paper reflect a winter theme. Some kit materials are on the shelves, such as the *tripod magnifier, plastic insects in a container* and an empty *insect container*. The top shelf has a *terrarium* with a turtle. A sign gives the turtle's name as Petie. There are also *science books* and a *poster* from the kit called *When do Animals Sleep?, a tray with nested cylinders of different textures*, and *plastic mixing and cutting tools*.

The above materials are mainly from the original tool kit. The new kit is on the floor and appears to have most, if not all, of its materials intact, some unopened. The children's journals are on top of it. The table and four chairs are also squeezed into this area, and the shelves are not easy to get at or to see. The teachers, like some others in the project, have concerns about damage or loss of the materials and about children using materials inappropriately. Although many other materials in this classroom are freely available to children during activity time, teachers appear to want to retain control over most of the science materials, and they are typically used only for a particular teacher-led lesson in which a few children participate.

One of the teacher's efforts to ask open questions is demonstrated during the mixing activity planned for this day. These questions have an "either/or" quality and often invite the answer Ms. Johnston has in mind.

> After the four children chosen for science are settled at the table, Ms. Johnston says to them, "In winter we drink things to keep us ______?" No one responds, so she fills in her own blank, "warm."

> She says they will make cocoa and it is a winter drink. She asks what else is warm in winter to drink, and mimics drinking from a mug. Some children say, "coffee." She asks what else, but no one responds with what she wants to hear, "tea," so again, she supplies that word. Later she asks, "Is cocoa hot or cold? Two girls respond, "hot." Ms. Johnston then asks, "So what kind of water do we need?" Again no one answers, and she says, "hot."

At the end of the lesson, Ms. Johnston asks children to draw in their journals about their experience. This journal work is consistently done after each science lesson observed by RFA researchers. As the children draw, Ms. Johnston asks some further questions.

> "What else could we drink to keep us warm in winter?" Many answers come forth, "Hot chocolate, cocoa, coffee, hot soup." Ms. Johnston says, "But I'm thinking of something." She again pantomimes drinking from a mug. No one gets it, and she says, "Tea. You can make tea and have a tea party." (Fieldnotes January, 1997)

Although Ms. Johnston is asking the children questions with language that appears to invite a range of responses, she indicates by intonation and repetition of the question, her search for a particular answer. There are times when the children appear to opt for waiting to hear what she has in mind, rather than volunteering their ideas.

Similarly, the lessons the teachers plan have a goal. Teachers want children to "discover" a particular concept, and then document it in their journals. This is especially evident during a February, 1997 visit when much confusion surrounds a lesson on blowing paint on paper with a straw. Ms. Johnston wants children to realize that their breath can make the paint move, but the children have other ideas.

> I am struck by the different ways the children approach the task. Maria is all into everything. She gets more paint. She gets it all over her sleeves. She blows forcefully and is able to move her black paint around. Soon she has made a large roundish shape from a much smaller blob of paint. Siree, on the other hand, soon gives up on trying to get the paint to move by blowing through the straw ... She instead chooses to use the straw as a pen and moves the paint that

> way, creating lines of various kinds. Perri has discovered that you can also paint with the dropper by tapping it. She goes back and forth between making dots using the dropper and blowing the paint around with the straw. Zak finds his straw useful in scraping some paint out of the cup and onto his paper.
>
> Ms. Johnston shows Maria how she can use the dropper to add more paint to her paper. Earlier Maria had just poured the paint onto her paper directly from the cup. Ms. Johnston says, "Now, blow!" Maria blows ([but] not through the straw!) Ms. Johnston seems confused. ... At this point she notices Siree's painting and says, "Siree, you didn't blow it." The children continue to experiment as Ms. Johnston is called away briefly. ... When she returns she is clearly disappointed. She tells them, "I wanted you to think how paint changes with blowing." (Fieldnotes February, 1997)

In the same month, there is a telling moment with Ms. Rivera. She has planned a lesson about taste with the children, and it has somehow gone awry. She had forgotten to bring in some of the toothpaste she was planning to use. But after that lesson ends, there is an exciting moment when the children have asked to take the turtle out of its aquarium. As the turtle gets on the table top and tastes freedom, he begins scurrying madly for further escape. Ms. Rivera hurries to keep him from falling off. After further activity, more and more children have come to see, and there is quite a lot of noise. Ms. Rivera worries ... "You're gonna scare him. I wonder how fast his heart is beating? Do you think he has a heart?" (Fieldnotes February, 1997)

Finally, things calm down, and Ms. Rivera says to the researcher, "I wanted to have them think about the tastes of the toothpaste. She realizes the tastes got mixed up. Then she says, "I still can't ask open questions. What are they?" The researcher tells her she heard her ask a couple about the turtle, "I wonder how fast his heart is beating? "Does He Have A Heart?"" Ms. Rivera is surprised and brings up this moment later at a focus group and also during an interview. She says it was a turning point for her, a moment of understanding about open questions.

In March of 1997, following journal writing, Charity and Arnette ask to take out the caterpillar that Ms. Johnston brought to school. Ms. Johnston is doubtful about whether the caterpillar is still alive. (She had found it and brought it in some weeks ago, then had forgotten about it.) After some searching in the dry soil of the container, Ms. Johnston helps the girls find the caterpillar. It is alive.

> Ms. Johnston has it in her hand, and she passes it to Camille, who has joined the little group. Camille then gives it to Charity, who screeches in delight, "It tickles. He's tickling me." She drops the caterpillar and runs off to tell others, "I touched the worm and it tickled me." Ms. Johnston in the meanwhile has gotten water and pours a little bit on the plate. "What happens," she asks. "Does he like water?" Camille responds, "I don't know." Then she decides he must not, because he's "running" away from it. Arnette thinks it is "because [the water is] cold." Charity suggests they use hot water, but Ms. Johnston says they can't.

Later there is much delight when Charity is alone with the caterpillar. She peers intently at it and tries to get it to respond to a small pebble she drops near it. Suddenly she goes over to Camille to share her discovery, "Look, he do pee." Camille asks, "Where?" and Charity answers, "I can feel it." (Fieldnotes March, 1997)

Ms. Johnston does not question or prompt these girls about the caterpillar, nor does she encourage them to continue investigating, but she is willing for them to experiment with it, and in fact assists them to retrieve it. Further, it was she who brought the caterpillar in to school.

By April, seven months after this classroom has begun the Science All Around Us project, there is a big change in the classroom's physical space. A small number line is up at the children's eye level. Science materials are more accessible and " ...the whole science area has been transformed into an outdoor scene." Books from the kit are on display, and gardening materials are on a table. Drawings of the outdoors done by children and teachers are on the wall. Other materials from the kit are in other areas of the classroom: *Musical instruments* in the library, *gears*, and *village blocks* in the block area, along with a book, *Up Goes the Skyscraper. Mapping the Town*, a game, is in the puzzle area, and a poster documenting a list children have dictated about Things That Grow is in the entry way: Flowers, potatoes, trees, tomatoes, my mommy's stomach, your hair, your body, fruit, pets, etc.

Later in April, the class goes on an outdoor search for "things that are not alive." They have talked about this in the classroom, and the children have named some things that are not alive and some things that are. This is a direct result of the same activity carried out at a recent museum professional development session. Children busily gather items from the outdoor area and stick them onto masking tape "bracelets" that Ms. Johnston has supplied. When all are done, Ms. Johnston says, they will go inside and "We'll talk about what we've collected. We're collectors. We're scientists." (Fieldnotes April, 1997)

In May 1997, at approximately the end of their first year's experience in the project, an interviewer notes "Key in [the teachers'] description is their personal interest and commitment to make science happen in their classroom. They care a lot about the children learning all they can." She quotes the teachers, "Generally we're more aware of science. We take more of a personal interest. We ask, 'How can I make this into science?' ... And before our science was nothing, like, 'How many apples can I count?'"

Ms. Rivera tells the researcher how she has adapted a game to suit the children's ability or need; she also has suggestions such as using clear plastic sieves and coloring the oil in the water filtering activity so that the process is more visible to the children.

Ms. Johnston tells the interviewer that all the children want to respond [to questions and in discussions], and they give them the time to do that. "By us being more motivated, that motivates them, and they all want to say something." She says that the children see the teachers really interested in their responses. "The adult excitement promotes their excitement." (Interview May, 1997)

In the fall of 1997, the second year for this classroom to participate in the project, the setting continues to be open and inviting, the room appearance esthetically pleasing, and the "science lesson" arranged and more or less teacher controlled. However, there does continue to be time for some incidental discoveries to happen, though at this visit they are not science discoveries. Posters and books from the kit are in evidence. This beginning of the year time is hard. Teachers must focus strongly on management, integrating new and often very young children, and on helping everyone to become part of the classroom community.

A moment of incidental learning does come up when Ms. Johnston is using the *lollipop drum* (a metal drum with a single handle, painted like a lollipop), supplied in a recent kit, to encourage the children to experiment with movement and rhythms. After the activity, Ms. Johnston encourages the children to draw about the experience in their journals.

> As this is winding down, one of the boys pick up the drum and sees it catch the light, which reflects on the wall. He is excited as he moves the drum and sees the light move. Ms. Johnston is also immediately excited. Her face lights up as she explores with him where the light is coming from. She quickly sees that the sunlight coming through the window reflects from the drum and casts the bright spot on the wall. She gives the drum back to the child and runs her fingers along the wall to see what effect that will have on the spot of light. A girl comments that it looks like a cockroach, which indeed it does! She wants a turn to try. Meanwhile Ms. Johnston has announced that it's about time to clean up. She leaves the table and begins to put their pictures up on the wall. The boy has the drum back and hits it while he sings a rhythmic chant. (Fieldnotes November, 1997)

Ms. Johnston is clearly intrigued by the reflection as she experiments to see what effect her fingers have on the reflected light; however, she knows that her schedule for clean up has to be maintained or the group will not get its turn on the shared playground. The researcher wonders if she will pursue it on her own at a later point.

In December of 1997 Ms. Rivera has planned a lesson in which four children are to trace their bodies. Before they begin she engages them in discussion and helps them find and experience their bones. They look at the skeleton poster, which came in the kit, and she encourages them to feel for their own bones inside their bodies, using the poster as a reference. She points out differences in size among them, comparing her taller height to a child's smaller height. Ms. Rivera suggests that the children bend knees and elbows, make fists, and finally barefoot, wiggle their toes. They all get giggly over their bare toes.

> Ms. Rivera suddenly looks up and starts to talk with the researcher. She wonders if footprints can be used for identification just like fingerprints. They talk about babies' footprints when they are first born. Ms. Rivera says she's not sure when fingerprints are fully developed. Maybe that's why they use footprints. She says she wants to find out more about that.

As the children follow directions and draw their bones into the traced body figures, they turn out looking like multiple parallel horizontal lines -- somewhat striped! Ms. Rivera compliments the children on their good work, and she and Ms. Johnston agree that their traced bodies and bones, along with others that have been done, will be posted in the hall. There is not the slightest doubt that they are wonderful or that the "bones" are not quite accurate!

Later Ms. Rivera tells the researcher that she thinks the children would love to see real bones. The researcher suggests boiling a chicken or turkey carcass that the kitchen might get, or some knuckle bones. They also talk about a medical museum in the city that might have something to offer, and Ms. Rivera is excited. She immediately tells Ms. Johnston, and they determine that they are going to call, as it is close to another museum they are scheduled to visit the following month. (Fieldnotes December, 1997)

As this school year continues, these teachers have been able to allow the children more freedom to explore during planned lessons, but even more significantly, the teachers themselves have had opportunities to become interested when new thoughts occur to them. The reflected light, the wondering about footprints and bones, just as the excitement about the turtle in the previous year are probably only a few examples that happened to be observed of the teachers' growing wondering about scientific phenomena.

During another winter observation, children and teacher are relaxed and comfortable. The teachers have now been in the Science All Around Us project for a year and a half. They have just gotten a new kit from the museum and are excited about it. Ms. Rivera says to the researcher, "As time goes by, we know how to use the kits and how to incorporate the science into whatever is there. ... You don't need to have a theme. Science doesn't necessarily have to fit your theme ... or else you never get to it.

We're doing that more. Science as science whether it matches our theme or not."

During activity time Ms. Johnston leads the children in making playdough. She talks with them about water, about quantities -- the concept of the difference between a drop and a cupful are explored. They feel and taste the dry ingredients of flour and salt and experiment with consistency and color using food coloring. Ms. Johnston asks many questions as they work. In contrast to last year's questions, she accepts their answers without any prejudice in favor of her own goal for what she wants them to learn, which has been present in many previous lessons observed by the researchers:

> Ms. Johnston: Where do we find water?
> Child: Sink
> Ms. Johnston: What do we use it for at home?
> Child: Dishes
> Second child: Body.
> Ms. Johnston: (Pointing to a recipe posted nearby which shows one cup) How much do we need?
> Third Child: One drop.
> Ms. Johnston: Do you think we can mix it with one drop? (She lets them try.)
> After placing one drop in, the children see not. "No!"

When they have resolved the water issue, they are ready for the flour and then salt. Similar interchanges occur. Ms. Johnson's questions are:

> What does it [flour] feel like?
> What else does it feel like?
> What else can we use flour for?"
> Let's taste it."
> Feel the salt, now feel the flour. Do they feel the same?
> What does it [the food coloring now added] look like?
> What do you think will happen when we mix it all together?

When Ms. Johnston comments that she thinks the mixture seems a bit wet, she asks the children, "What do you think we should do so it feels better?" A child responds, "Flour." Ms. Johnston says, "Let's try that." She lets them add flour and says, "What's happening?" The activity continues for some time with children mixing another batch of playdough, again determining what is needed. Then they compare the first to the second batch. Throughout the teacher asks open ended questions and allows children to follow their own ideas and see the results. When oil spills, she allows them to mix their playdough into it but stops them before things get out of hand.

The children use their playdough to make different shapes and objects, sharing together and connecting their pieces. Ms. Johnston has set the tone of enjoyment and experimentation, and the children have picked up on that. They feel free to try things out without concern for an expected outcome. This is in contrast to previous lessons, such as the one on mixing cocoa, when Ms. Johnston wanted a particular answer from the children. At the end of the activity, a child adds more color to her batch.

> She does this without asking but also with confidence that it is okay -- rather than surreptitiously. Another child adds more flour to his. Right before the lights go out to indicate clean up, the four children are all singing, dancing and pounding their clay as they make various things. (Fieldnotes February, 1998)

The last observation of these children and their teachers takes places at a Family Event at the Please Touch Museum. Ten parents have come to the museum on this weekday morning: Seven mothers, a father, and a mother and father pair. Some took off from work in order to come. The museum staff have set up lots of activities for children and their parents to explore in a private theater before the group goes up to the exhibit floors.

A researcher notes that the magnet activities in particular have captured the imaginations of both the children and their parents.

> I walk over to speak to Ms. Johnston and a mother with whom she is speaking. Marquel, the woman's child, is using a magnet to raise the metal spoon that is in a large, partially filled vat of water. Meanwhile, his mother wonders how it works: Does it have to do with gravity? With the magnet's force? Perhaps it falls when the spoon enters the air because of gravity? She has many hypotheses and is eager to solicit Ms. Johnston's opinion on the process. The conversation continues, and Ms. Johnston comments that Marquel could easily be amused by this activity for "a really long time." His mother agrees and adds that

> she can easily set this up at home. All she'd need is a plastic container, some metal objects and a paddle magnet (the museum presented each child a gift of just such magnets at the end of the day).
>
> When I speak to Marquel's mother, she relates details of a recent body drawing lesson. Her son, she tells me, was the one who insisted that his head was bigger than it had been traced. She laughs and then adds how pleased she's been with the science program. She herself was always interested and good at science as a student. She was never a "squeamish" student. She tells me that she tries to do fun activities with her children when she can, but most of all she loves to ask them what they are thinking; "they have so many imaginative ideas, you know." (Fieldnotes March, 1998)

A little later in the morning, the researcher gets a chance to speak to Ms. Johnston. She asks her what they have tried from the new kit. Ms. Johnston lists a few things and then remarks, "I try and fit things in. Ms. Rivera, she always just puts things out." She goes on, "I really like the books." I always have, so we've been reading those. The conversation ends when another mother sits down on a truck that is part of a gas station exhibit. She is tired. It takes a lot of energy to follow her young son through the exhibit. Ms. Johnston takes this opportunity to tell the mother how much they've missed her presence in the classroom this year. The conversation in genuinely friendly, and the mother expresses a desire to get back to volunteering more regularly now that her personal life is slowly returning to normal. She loves being in the classroom.

At the end of the visit, the museum staff pulls together the parents for a brief discussion about the project. The morning's activities have clearly inspired at least some of the parents. One mother commented that she has gotten some ideas from today's event; in particular, she is planning to set up the spoon, water, magnet activity--all the materials needed are materials she has at home. Another mother remarks she was surprised by her child's excitement at the "snake activity" (a paper clip is attached to a cloth snake, using a magnet one is able to "charm" the snake). In particular, she was surprised by her child's "wonderings about why" it worked.

In different ways, four of the mothers speak of the transfer of ideas from the classroom to their homes. Some describe with enthusiasm activities their children have done in class. Others relate incidents in which their children have brought activities from class home. One mother relates a story of a cookie making activity gone awry. Upon seeing her mixing batter, her child got excited, crying, "claydough!" Soon, she relates, she found they'd made "brown clay:" her child had insisted on adding more and more flour to the mixture until the cookie agenda had been subverted. Some of the other mothers in the group, who'd said they frequently bake with their children, have knowing smiles on their faces as this story is related.

This is a story about the process of teachers coming into a more open-stance toward early science education. In it we see two teachers working hard to implement more flexible science activities and to change the nature of the questions that they ask the children in their classroom because they too want to hear the "many imaginative ideas" children entertain in their heads. While these two teachers have made great strides toward this goal, they continue to feel caught between their desire to encourage discovery and their own understandings of school, as well as the pre-existing structure of school; thus for example, Ms. Johnston must cut short her own and the children's exploration of reflection in order to keep the class on schedule, so that they can make it outdoors. Further, even after two years in the project, there is little opportunity for children to explore science materials on their own because mostly such materials are accessible only during teacher-led activities. There are indications that this may be changing as Ms. Rivera continues to push to "just put things out." Finally, at a center which works hard and relatively successfully, to foster family participation, we see evidence of the Science All Around Us project seeping into the home lives of children who's parents may or may not have been "young scientists."

Chapter Three—Outcomes, Findings and Implications

The stories in the previous chapter and data from other classrooms, interviews, focus groups, meetings and surveys comprise the basis for major findings of the Science All Around Us project. Arranged within the five topics described below, the findings are presented in this chapter and are followed by implications that they suggest. As the stories have shown, after museum educators organize and present the kits, teachers move to the center of all of the data regarding implementation of the project; thus, strong among the findings are those related to teachers' professional understandings and the time it takes for teachers to become familiar and comfortable with new ways of working with children and each other. The following questions are addressed in these findings:

How were science and math materials developed and used?

How did the materials, professional development and classrooms impact on children's learning?

When the Please Touch Museum conceived its Science All Around Us project, they saw their major mission as the **development of science and math materials** suitable for three and four year old children. The museum planned to gather and/or fabricate sets of materials that would spark children's interests and science discovery.

As the project went forward, museum educators became aware of the importance of **integrating curriculum** already present in classrooms into the themes of the kits they were developing. They reorganized the kits to allow for more flexible integration of science and math with other classroom activities.

As it became increasingly clear that teachers were key players in the project, greater emphasis was placed on **professional development.** It was designed to include a range of opportunities for discussion and analysis of classroom events, hands on activities, and collegial sharing.

Throughout the research, data indicated that the **classroom climate and tone** had significant impact on how materials and curricula are received and integrated by children. Invitations to wonder and discover were affected not only by language, but also by other classroom expectations and structures. Data also showed that teachers became more enthusiastic about science as a direct result of children's interests.

Analysis of children's activity and language enhanced understanding of young **children's learning**. Research for Action developed a hypothesis that described children's learning as circular and spiral rather than linear. This helped illuminate some of the children's play and discovery.

In addition to the findings, the final section of this chapter offers some indications and possible future directions regarding the **complexity of museum and school relationships**. These indications examine the culture gap between museums and schools, the many roles expected of museum educators, and prompt thought for future museum and school related projects.

Findings

DEVELOPMENT OF SCIENCE AND MATH MATERIALS

I. NEW SCIENCE AND MATH MATERIALS HAD A SUBSTANTIAL IMPACT IN THE CLASSROOMS OF THREE AND FOUR YEAR OLD CHILDREN. In eight out of the nine classrooms that Research for Action followed, science and math activity and provisioning increased compared to what was available before the project began. The data from classroom observations, teacher interviews, focus groups, and surveys unanimously confirms this. As the classroom stories in the previous chapter revealed, after kits were introduced, children became more involved with a greater variety of science and math materials and were choosing those materials more frequently than before. For example, in the prologue story, Ms. Casey asserts that the children previously were barely interested in science materials she put out. This was confirmed in early classroom visits to other classrooms as well. But when the kit materials were visible and available, in Ms. Casey words, they were "dying" to get to it.

- The quantity and quality of science materials became more visible and accessible over time. This finding was evident in the 1995-1996 analysis of the pre- post-survey administered to Cohort One in September 1995 and again in May 1996.

  Overall, teachers reported a definitive increase in the use of science materials by large and small groups and individual children.

  - Although the availability of science and math materials (magnifiers, natural objects, small animals, balance scales) offered on the science table or otherwise did not change dramatically (with the exception of balance scales which were widely more available), Cohort I teachers reported that the numbers of children using or playing with these materials increased (2 of 4 reported that majority of children used these materials in the pre-kit survey while 5 of 6 did in the post-kit survey).

  - In the post-survey, teachers judged that during activity time the use of the science area, balance scales and magnifiers was more frequent than they had indicated in the pre-kit survey. (In the pre-kit survey, 1 of 4 teachers indicated these areas and/or tools were used often in contrast to 5 of 7 in the post-kit survey.)

  The results of the summary[12] of the survey administered to Cohort Two teachers in May 1997 indicate that a significant percentage of children in their classrooms were using a variety of materials related to science by the end of the first year in the project (*Chart IIIa below*).

[12] As discussed in Chapter One, due to the changes in Cohort Two, RFA was not able to do pre/post analysis of the surveys administered to that group of teachers in the 1996-1997 school year.

	N/A	Never	Sometimes			Not Sure
			At least 1-3 times a week	1-3/wk	4-5/wk	
	0	11% (1)	89% (8)	22% (2)	67% (6)	0
	0	0	100% (9)	78% (7)	22% (2)	0
	0	11% (1)	78% (7)	44% (4)	33% (3)	11% (1)
	0	0	100% (9)	44% (4)	56% (5)	0
	0	0	89% (7)	63% (5)	25% (2)	13% (1)
	11% (1)	0	89% (8)	45% (4)	45% (4)	0
	11% (1)	0	78% (7)	56% (5)	22% (2)	11% (1)

These survey results were consistent with the qualitative research findings. Early visits to classrooms showed some science materials, usually confined to a small space or table, often looking little-used. Later research visits to all but one project classroom showed expansion of science areas and a greater variety of science materials available. Two stories in the preceding chapter show good examples of this change.

Later research visits to all but one project classroom showed expansion of science areas and a greater variety of science materials available. Two of the stories in the preceding chapter show good examples of this change.

In the story called "*It's Set Up ... And The Kids Just Carry On*", science began as a strong interest of the assistant teacher, Ms. Gregory. As time went on, more animals and options for discovery filled the classroom. Tanks filled with animal life went from one to four. More and more artifacts filled the science area, which expanded as well. The director was especially supportive and commented during an interview in May of 1997 that science and math had spread throughout her entire center. She talked about having to save every single plastic soda bottle because all the teachers wanted them for mixing, and she said that oobleck was getting into everything, even the computers!

Ms. Chiu and Ms. Marks' classroom, in the story, "*We Don't Worry About Making Mistakes*," showed similar growth. When the study began, their classroom was bright and much was available for play, but science materials were not prominently displayed, and children were not going to them. Even after the science kits were first distributed, children appeared to pay little significant attention to the materials they contained. By the end of the first year, however, this classroom was notable for the independent science activities that came up as students had more access to more materials. In February of 1997, a researcher noted "an abundance of science related materials easily accessible to the children as well as the ever growing animal life of the classroom." During later visits that year, children independently experimented with magnets and siphoning water while with their teachers, they fed animals and made oobleck.

- <u>Another factor related to time concerns cycles of time in classrooms of very young children.</u> In the fall, many new three year-olds enter Head Start and day care centers. Major energy is put into integrating these children into the culture and routines of school life. In the second year of the project, research showed that in some classrooms, one third of the school year might pass before teachers could refocus significant attention on the science and math kits. Because plans to observe Cohort Two classrooms at the beginning of a second year in the project were curtailed due to personnel changes described earlier, this was evident in only a few settings. Where this effect was seen, teachers picked up in early winter where they had left off the previous spring.

- <u>Materials in the kits proved stimulating and were the focus for new science activity</u>. Materials were adaptable to much of children's spontaneous play. Children played at housekeeping with particular delight as they experimented with mixing and changing activities. In February of 1996, in one of the Head Start classrooms, they pretended to make pancakes and scrambled eggs as they combined liquids and solids using kitchen utensils provided in the kit. Children in the same classroom joked and tricked one another as they played with magnets. In March of 1997, in one of the private day care classrooms, stethoscopes and anatomy aprons led to setting up a "clinic," and exploring careers of doctor and nurse. Teachers at a May 1997 focus group reported that they liked the transportation and mapping games in the recent kit. They had thought that they would be difficult for their children, but as they tried them out, adapted them, and taught them to the children, they discovered that they were fun and that the children wanted to play them repeatedly. In one assistant teacher's words, "[it's good to see the children] using something other than paints, crayons and markers."

- Children's books supplied with kits, which were directly tied to kit themes, were extremely popular. In formal and informal interviews as well as at focus groups, teachers stated repeatedly that these books enhanced their science programs, enabling them to use literature and language to reinforce ideas and spark discussion. In five of the six focus groups Research for Action conducted with Cohort One teachers over the course of the project, teachers mentioned how useful they found the books from the kit.[13] Often such comments were in the context of discussions about how hard it is to find books that tie into what they are teaching. During the focus group in May 1997, the teachers were specifically asked about books. All teachers liked having them. One teacher gave an example, after asserting that the books were "real important." She told of children taking a book about rocks all over. "The kids learned so much and what is actually made out of rocks. I ... even learned some things that I didn't know ..." At the reunion focus group for Cohort One, which took place six months after their official involvement in the project had ended, teachers from three classrooms spontaneously spoke of how they were incorporating childrens' literature into their various science activities.

Early material surveys often did not question respondents in detail about the books; however, with the development of two of the reconceptualized kits in the 1996-1997 school year, RFA surveyed Cohort One teachers' reaction to the books in the one new kit they received and Cohort Two teachers' reaction to the books in the two

[13] The one focus group in which teachers did not speak of the books was one which focused on aspects of the project other than kit materials.

new kits they'd received. Chart IIIb (below) indicates that while some books might have been less useful than others, overall teachers responded to the books very positively.

BOOKS BY NAME	USEFUL	SOMEWHAT USEFUL	NOT USEFUL
The First Snowfall	100%	0%	0%
The Listening Walk	89%	0%	11%
Peter's Chair	100%	0%	0%
Quick As A Cricket	75%	0%	25%
Earthdance	56%	0%	44%
On the Day You Were Born	40%	60%	0%
King Bidgood's ...	100%	0%	0%
The Science Book of Water	80%	20%	0%
Clap Your Hands	100%	0%	0%
All About Sound	80%	20%	0%
I'm Growing	100%	0%	0%
My Five Senses	100%	0%	0%
Everybody Has a Body	100%	0%	0%
My River	75%	25%	0%
Boat Book	60%	20%	20%
Flying	75%	25%	0%
Trains	60%	20%	20%

- Teachers Guides, included with each kit, were important. A balanced guide that offered some ideas and activities to start teachers off, but also left lots of room for teachers to develop activities independently was most useful. Museum staff tried many versions of guides, from some that were no more than a few open questions about possibilities, to some that were crammed with hundreds of ideas on a theme. When the very open ended guides were sent out, teachers did not appear to find them helpful. They were sometimes returned unused.

During an interview in January, 1997, Ms. Rivera, from the story, "*Does He Have a Heart?*" explained that the open ended teachers guides were not easy to use because they didn't quickly translate into activities that could go into lesson plan books. By contrast she showed the interviewer some *Scholastic* activity books and said, "You can just open them and get an idea to put in the plan book." Both Ms. Johnston and Ms. Rivera explained that they don't have time to sit and think about plans. They wanted specific suggested activities along with the materials in the kit. Ms. Rivera said, "I am just learning myself, so how can I come up with ideas?" She added that if there were activities suggested, she might be able to think further to add on to them or change them. (Interview January, 1997)

Museum educators continued to value highly responses from teachers, thus teachers voices guided the eventual decision to aim for a middle ground in the guides, to include more background information and to make sections of the guides more accessible by adding index tabs. Museum educators also balanced specific activity ideas in the guides with suggestions that helped teachers to think creatively about the possibilities some materials might offer. Teachers found this balance the most useful.

- <u>Teachers wanted these new materials to remain in their classrooms.</u> Teachers ordered science materials similar to those contained in kits. At the end of the 1995-1996 school year, several teachers spoke of using their discretionary budget money for science materials. The following year, at a focus group in May 1997, teachers shared information about catalogues for science materials and two teachers reported that they planned to spend their entire materials budget on science. Another teacher said she was planning to bring science ideas to the retreat that her center has each summer. She knew that other teachers were interested and thought they could order together and share the materials throughout the coming year.

An extension of this was seen in the "*It's Set Up ... And The Kids Just Carry On*" story in which Ms. Gregory wrote for and received a grant to purchase one of the museum's kits for her classroom. Teachers' efforts to purchase science materials were noted by the directors, who were interviewed separately, and who each expressed pleasure that they saw teachers ordering science materials that they hadn't thought of ordering before.

Implications: Development and distribution of science and math materials, packaged with children's books and appropriate teachers guides, and accompanied by professional development, is productive and should be continued further. Listening to teachers' voices and opinions is an important part of this process as it is clearly teachers who are prime motivators of the children and who know best what is successful with them.

INTEGRATING CURRICULUM

II. KITS WITH MATERIALS ORGANIZED INTO UNITS THAT FIT ACROSS THE CURRICULUM PROVIDED BETTER ACCESS AND MORE ENTRY POINTS FOR TEACHERS THAN PREVIOUS SINGLE THEME KITS. The reorganization of kits into broader and more inclusive formats was welcomed by teachers. In most classrooms, teachers worked with themes that had been planned in advance, often with other teachers in their centers or schools. Originally, teachers had to "add on" the science ideas from the kits. They were creative about it, but it was often difficult to fit everything in. Ms. Casey, from the *Prologue*, spoke during an interview in May 1996 of regularly having a transportation theme. "Normally we do transportation [as a curriculum unit], but [the kit] just made it even better because there were things from the kit we used, and we grew from that."

- Kits with materials that could be used in several ways or in various areas of the classroom were more extensively used by teachers. In interviews, during focus group discussions and in materials review sessions, teachers indicated that the *reorganized kits* were easier for them to use because the materials could be used in a variety of ways and/or in different areas of the classroom. Teachers also commented that these materials sparked more spontaneous use by the children. For example, Ms. Daniel told about binoculars that might once have remained in the science area now being used "all over the room." Children were using them to watch for their parents as they came to pick them up, and Ms. Gregory added, they were using binoculars to look out the window at people working on the roof across the street. (Focus Group, May 1997)

- Some of the wider use of new *reorganized kits* may have been related to teachers' time and familiarity with the materials. For instance, RFA heard from Ms. Rivera, in February, 1998, that when kits were more familiar to them, the teachers were not quite as concerned about the fit between theme and kit. As museum staff disseminates reorganized kits to greater numbers of teachers for longer periods of time, they may be able to assess whether thematic congruence between kit and pre-existing classroom curriculum is essential to easy use or if it is one phase in a teacher's growing understanding of exploratory science for young learners.

Implications: Kits and projects for early childhood classrooms must go beyond the simple development of materials, and must include understandings of "fit" between the realities of classroom life and the possibilities for early science education. Indications from research in this project show that broadly organized science kits which include a wide range of familiar material can offer many entry points across themes and school curricula. Teachers can use materials in ways that make sense to them, ways that fit in with what is already going on in their classrooms, and ways that expand those possibilities.

In the classrooms of most three and four year olds, curriculum and activities are not sharply divided into content areas; thus, there is real opportunity for integrating science within the natural flow of the day, something that is typically a goal of classrooms for older children, but not always achievable due to the complexity of meeting multiple curricula demands.

PROFESSIONAL DEVELOPMENT

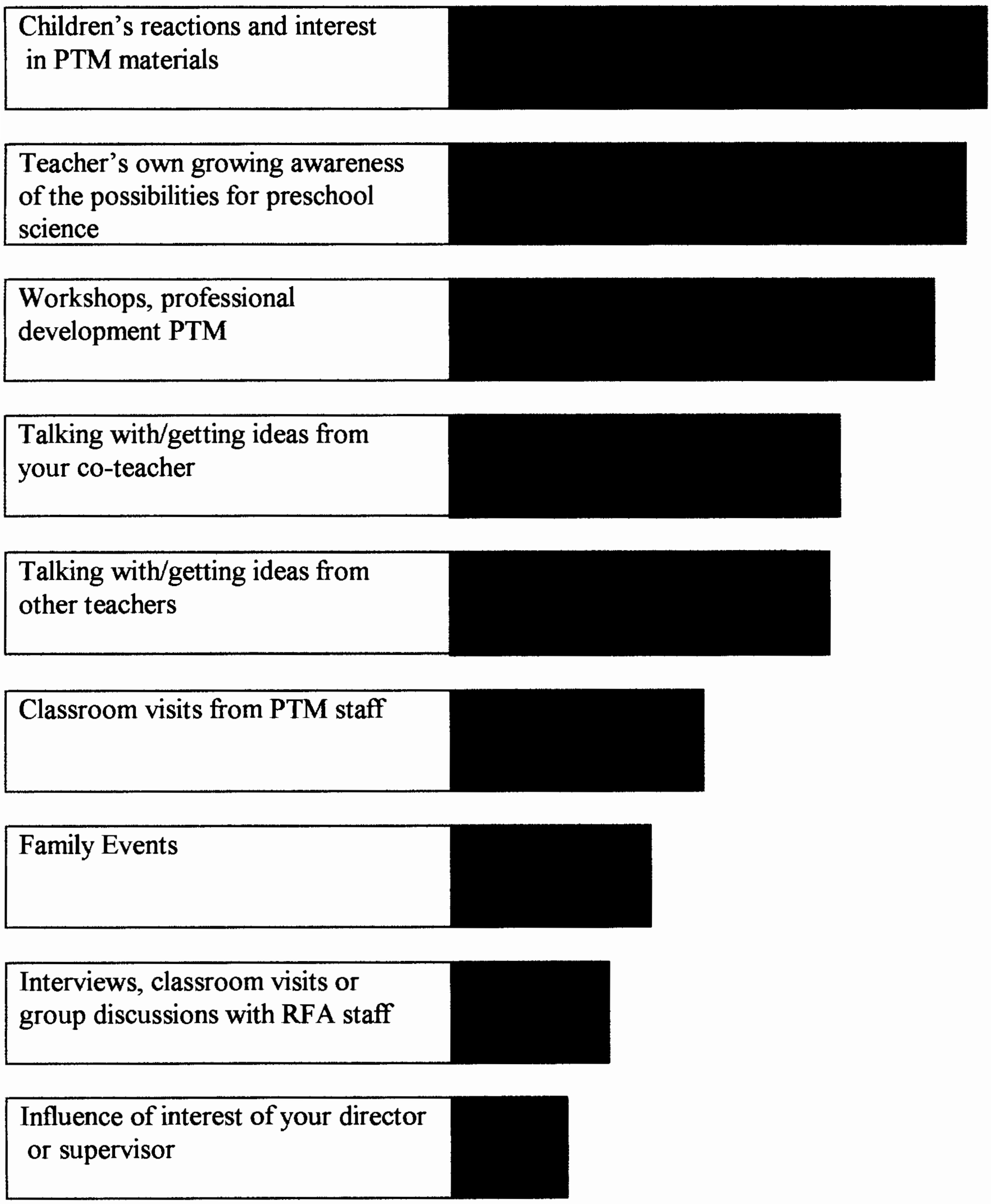
III. PROFESSIONAL DEVELOPMENT SESSIONS FOR TEACHERS TOOK ON CENTRAL IMPORTANCE IN THE PROJECT AND WERE CRUCIAL PARTS OF THE MUSEUM STAFF'S CONTRIBUTION TO THE SUCCESSFUL IMPLEMENTATION OF SCIENCE ALL AROUND US. During more than one meeting with directors and supervisors, the importance of professional development as an essential component of the project was mentioned. One supervisor commented, "I've seen kits just sit on a shelf. I don't see that happening here." At the end of their second year in the project, in May 1997, RFA conducted a survey with the Cohort One teachers about important influences on their science teaching practice. The teachers ranked professional development as the third most important out of nine influences listed (*see Chart IIIc*). Sharing ideas with colleagues, both individually and in small groups, which also happened often at staff development sessions, followed immediately as the fourth and fifth influences.

The professional development findings in this chapter are divided into three sub-heading areas: Content and Methodology; Personal Development of Teachers; and Lasting Influences.

<u>Content and Methodology</u>

- <u>Professional development at the museum, directly related to the kits, gave teachers ideas and increased their awareness of possibilities in science</u>. Teachers' understandings became a central focus of the project. During interviews and focus discussions, teachers made reference to professional development sessions which were helpful. Often, they said, they went back to their classrooms and immediately put into practice an activity or an idea presented at the museum session. Experiments showing the "skin" of water surface was tried in a classroom soon after it was done with teachers at the museum in late 1996. The same was true of the concocting of oobleck, which many classrooms picked up on. The outdoor collecting walk taken by the class in *Does He Have A Heart?* was first experienced during professional development at the museum; Ms. Johnston, of that story, also tried cleaning water through sieves with successively smaller openings, an activity which was demonstrated during a 1997 museum staff development session.

Chart IIIc: Teachers' Priorities: Cohort I, May 1997



- In addition to introducing science and math content, professional development had to alert teachers to new ways of thinking about active learning and inquiry, which the project encouraged. Once again, a good example is visible in the story *Does He Have A Heart?* In that story, both teachers were trying hard to integrate what they had learned at the museum with the realities of their day to day classroom life. They spoke to a researcher about this tension in January of 1997: She then wrote, "They do not appear to know or understand how to bridge the gap between what they feel is expected by the school and what is expected by PTM. ... They come down in favor of the school's expectation, such as a quick activity to write in their plan books, and also perhaps their own internal model for how schools should teach." The researcher then comments, "not only are these two teachers dealing with a whole new area of science, with which they are unfamiliar and unsure, but they are being asked to teach in a whole new way, using open ended activities and questions. Perhaps it feels like too much to absorb." These teachers were, however, increasingly drawn by the possibilities of science activity. Ms. Rivera spoke about changes in their personal perspectives: "We observe nature more." They encourage the children to use all of their senses outdoors. They are trying to integrate science into their existing classroom themes, as described earlier, but they are not yet ready to make changes in basic structures or approaches to teaching.

  In other classrooms similar issues were present. Especially at first, teachers worked out ways to incorporate science into existing structures, such as themes already agreed upon, or daily schedules with small leeway for extended investigations. This kind of integrating did not require major shifts in either teaching pedagogy or daily routines.

- Staff development workshops that combined both open ended suggestions for exploration, and specific activities, were most successful. Teachers got further in their thinking and actually used their time more productively when given specific activities to carry out, or several guiding questions, than when they were simply invited to explore a new kit without such scaffolding. During the focus group with Cohort One in May, 1997, teachers talked about the kinds of activities that were most helpful to them. Hands on experience came up frequently: One teacher stated she found the sessions productive "because we actually got in and played with all the stuff, because they [PTM] had materials on hand. It's just having exposure and experience."

- Teachers valued as paramount the time during professional development sessions when they were able to share experiences and efforts with colleagues who were teaching in similar settings. This was apparent right from the start. At a November, 1995 focus group, Ms. Daniel (*"It's Set Up ... And The Kids Just Carry On"*) commented that she enjoyed the professional development sessions because she was learning how teachers from different places were using materials, often in ways she hadn't thought of. Throughout the project the professional development sessions provided a unique opportunity for teachers to expand their repertoires of science activities through the sharing of each other's experiences. As one teacher put it at a focus group, "It's unending all the things you can do. Just to come here and hear what people are doing."

- Teachers strongly urged the museum to set up a network that would allow them to continue the sharing they found so valuable. All teachers were vocal in their wishes for a way to have such meetings continue. During the reunion focus group held with Cohort One in December 1997, teachers urged the museum to organize such a possibility. They indicated that responses from colleagues were important to their deepened understanding of science content and their continued focus o science possibilities in the classroom. When the teachers were asked about what might get in the way of their continuing with the project's ideas, one teacher said, "We'd miss out on not having that networking time."

Personal Development of Teachers

- Most teachers needed time and more experience to feel comfortable with both "new" constructivist approaches to science and math and unfamiliar materials. As described above in relation to the content and methodology of the professional development, absorbing new approaches and new content presented a challenge. Time and experience were the key factors in this gradual process. Evidence about the influence of time, among other factors, has been seen in each of the stories told in Chapter 2. During successive observations in classrooms, changes came about slowly, not overnight. Teachers indicated that their own thinking was still in process: such as when Ms. Casey, whose classroom is described in the prologue, was gradually more able to handle insects and soil; or when Ms. Daniel talks about Ms. Gregory's influence on her thinking about science over time. It is also seen when Ms. Marks tells the interviewer in May 1996, "I wasn't a bug person, but this year, I've become more open. I wasn't a real animal person either." Her partner, Ms. Chiu then says, "But that's changed." Ms. Marks agrees, and then reminds Ms. Chiu about their joint efforts over several months to get the pH in the fish tank balanced.

At the reunion focus group, in December 1997, six months after Cohort One had completed two years of staff development and were no longer attending PTM workshops, Ms. Daniel spoke for many when she said, "I think this year [without PTM] science has been easier because of knowledge and information gained from the past two years, and maybe even knowledge that I had before that. It's more natural now; it's not as much of a task." This growing comfort and confidence was also remarked upon by the director of the parent-child center in "*Does He Have A Heart?*". In a June 1997 interview, she remarked on teachers' greater knowledge about materials: That "they can now walk into the Dollar Store and see potential in stuff they didn't have a clue about before" was strong evidence, to her, of this growth.

One teacher team wrote a note describing their thoughts as the project was winding down:

> Our thinking, language, viewpoints and actions have changed. ...We smile when a child tells us that her "shadow is behind me now 'cause the sun is in front of me," or when one child proudly shows us how they've "put it back together, just like a puzzle," pointing to their roll at lunchtime, and another tries and finds, "I can't. I ate some."

> When a child calls out for everyone to "Look! I made green. I put blue on the yellow," or points to the trees telling us we have "shade because the leaves came back," we marvel at how they've learned to truly see, to experiment, to share and take pride in their discoveries.

- Teachers' own professional understandings appeared to be a stronger determining factor in kit use than the kind of school setting in which the kits were placed. Teachers' backgrounds and educational experience were significant factors in implementing the Science All Around Us project. Teachers familiar with a more active approach with young children were able to embrace the ideas more quickly, and were able to create unique activities that did not depend as heavily on teachers guides or professional development sessions for direction. For example, in a classroom that originally had a very traditional approach, the teacher left mid-year and a new teacher was assigned. Familiar with constructivist ideas, she was pleased to have the science and math kits, and at once launched wholeheartedly into using them. She was observed in February 1997, doing a baking activity with children in which she asked many open questions. She took all of the children's answers and built upon them. When, at the end of mixing the batter, she asked if it would stay the same or change in the oven, many children said, "stay the same." Her response was, "Well, let's see." She was not concerned about the "wrong answers " the children had put forth. She knew they would have visible evidence after the cake was baked.

  Ms. Gregory ("*It's Set Up ... And The Kids Just Carry On*") was always a teacher who embraced natural science. During RFA's earliest visit to that classroom, she talked to children about silkworms and let them know they would soon be raising them again. Her pleasure at the new infusion of science and math that came with the Science All Around Us project was an inspiration to her partner, Ms. Daniel, and also to other teachers in her center. Her director talked about this during an interview in January of 1997. Ms. Gregory was also successful in obtaining a grant so that her center could purchase additional kit materials.

RFA did not see evidence of differences based upon site characteristics alone, however smaller sites with directors who were present on a regular basis did appear to make a difference. In such sites financial resources were more accessible and teachers were able to obtain more materials. Administrative support was also more available, offering teachers immediate feedback and allowing them more flexibility in meeting and sharing with one another. RFA saw these possibilities in both the parent-child center and the private day care center, described in the classroom stories.[14] However, day care or Head Start settings in the various facilities observed, all allowed for and encouraged significant increase in science activity if and as teachers became more comfortable and knowledgeable about kit possibilities. In the extended eighteen months of the project, the museum disseminated kits to suburban and private schools. It remains to be seen whether significant site based differences are observed there.

- An unforeseen but strong finding of this project was the growing strength of assistant teachers and their role in the classroom. By including assistant teachers in all staff development and research activities, these teachers were equally capable, along with lead teachers, of guiding activities, asking questions of the children and encouraging their explorations. At a focus group in May 1996 of directors and supervisors, a director remarked that she saw the assistant teacher involved in the program and planning, whereas before an assistant was "more comfortable with doing manual tasks like wiping down the tables and chairs and sweeping." She went on to say that the assistant teacher was "learning in very meaningful ways that [built] her self esteem and helped her feel like a competent teacher." During an interview in June 1997, a Head Start director also emphasized the program's strength with assistant teachers. She mentioned her appreciation of the museum's policy of including assistant teachers in all of the staff development and said she felt that at times, assistant teachers were more free to engage children in science and math activities when lead teachers had other required tasks to perform.

[14] Directors' support in these two centers probably accounts for the indications of directors' support on Chart IIIc.

When lead and assistant teachers were interviewed, or when they spoke in focus groups, they consistently used "we" when they spoke about implementing the project. It became clear early that teacher partnerships were supporting the project rather than individual teachers, and that teacher teams were developing. Ms. Rivera, the assistant teacher in *Does He Have A Heart?* was often the one to have good suggestions for improvements, such as making clear plastic sieves for water cleaning, and adapting games to better suit children's developmental ability. During the second year, when the new cohort had so many changes of assignment, assistant teachers in two classrooms were especially instrumental in keeping Science All Around Us alive and well.

Lasting Influences

- Teachers said they would continue their increased science focus even after support from the project had come to a close. The reunion gathering of the first cohort of teachers in December 1997, showed their continued enthusiasm and pleasure with science explorations. Unanimously they were sure they would continue. Ms. Marks said, "It [is] just a part of us now. Finding a place for the science table [is] just part of everything else." Another teacher added, "Science isn't an area in our room anymore, it's just kind of all over. ... We're just real comfortable with it. We've overcome messiness and we're just real comfortable." Ms. Casey (*Prologue*) took this opportunity to describe the way she thought a visitor might assess the difference between her classroom and another one that did not have the kits, "I think they would have to sit in our classroom [for] twenty minutes, and [then] twenty minutes in a non-participant class, and I wouldn't have to tell them anything. Just the questions children ask and our responses to the children, it would be evident." Teachers went on to talk about children's new found independence in choosing science, about the fact that it is now "cool" to choose science in the classroom, and about outdoor walks that sparked spontaneous collecting and exploration.

Follow up visits to two of the classrooms, whose teachers were part of this first cohort, showed that teachers were doing what they had asserted (these classrooms are included in the stories in Chapter Two). Expanded space for science, introduction of more science materials and children's freedom to explore and experiment were striking in the final visit to the classroom of "*It's Set Up ... And The Kids Just Carry On*." The classroom is alive and is described by the researcher as " ... fairly bubbling with activity." Many children were using hand lenses, color paddles, sorting through natural materials and calling to one another over their fun in discovery. "Look at this! This cool, right?" Later bubble blowing was set up and almost everyone participated. The final visit to the classroom in "*We Don't Worry About Making Mistakes*,' however, painted a slightly more complicated picture. There were many opportunities for children to explore the natural worlds of food, smell and critters, and the teachers' new found emphasis on exploration remained. However, in balancing their many priorities, Ms. Chiu and Ms. Marks find themselves incorporating science where they can into their other projects.

Implication: Professional development that is directly linked to new content and methodology is useful but also difficult. In such projects, museums must keep in mind that teachers vary greatly in their previous training and understandings, and may need time to integrate major shifts in their perceptions. In addition, since teachers value time to meet and discuss ideas, museums and school systems should take full advantage of this desire.

The establishment or continuation of science and math teacher study groups can be an important pathway to teachers' increased understanding and use of worthwhile science curriculum, and can contribute to lasting practices involving science and math. In such groups, teachers who are experienced can continue to explore and create fresh ideas. Teachers who are newer can learn more and gain support from peers. Finally, the value of including assistant teachers in professional development and networking contributes to the strength of a project as teachers can then work in teams that support one another as well as the children.

CLASSROOM CLIMATE AND TONE

IV. CHANGING CLASSROOM DISCOURSE AND ENCOURAGING CHILDREN'S FURTHER THOUGHT AND ACTIVE DISCOVERY REQUIRED MORE THAN A CHANGE IN THE TEACHER'S LANGUAGE. DATA SHOW THAT "OPEN QUESTIONS," WHICH PTM EMPHASIZED IN ITS STAFF DEVELOPMENT ARE COMPLEX AND REQUIRE A BROAD FRAMEWORK FOR ANALYSIS. This finding parallels the earlier finding discussed under content and methodology of professional development. In order to create a classroom climate of inquiry, teachers had to let go of the idea that asking a question implied obtaining an answer, sometimes a very particular answer. If a "technically" open question was voiced, but body language or other teacher signals indicated an expectation of particular answers, children could be confused, not answer at all, or stab for an answer that they thought the teacher wanted. The open question was easier for museum educators and teachers to speak about than to understand and integrate into classrooms, and was a major hurdle for most traditionally trained teachers to negotiate.

This difficulty was visible as Ms. Johnston made cocoa with a few children, in the story, "*Does He Have a Heart?*", and when Ms. Rivera in a February, 1997 observation pantomimed responses she wanted to hear from the children. She asked, "What do you have to do to be healthy?" She wanted them to realize that exercise (she did some) is good for you and that smoking (she pantomimed that) is bad for you. The researcher wrote that the children appeared bewildered. "Some look hard at the teacher and seem to be trying to figure out what is wanted." A teacher's tone and body language make a difference. As the above observation continued, it also became evident that when Ms. Rivera didn't get the answer she was seeking, she repeated the question until the "right" answer came up.

- Data show that at first teachers are more able to create open questions in the abstract, such as on a survey, or during a focus group discussion, than to actually frame open questions which generate inquiry in their classrooms. See Chart IIId (*below*) in which the questions Cohort Two teachers were able to produce on a survey, when asked to generate a series of questions relating to a hypothetical scenario, are compared with actual classroom discussions observed during visits to those same classrooms. Within this set, the degree to which teachers are able to generate inquiring discussions with the children in their classrooms varies. For the most part, this range seems to relate to teachers own pre-existing professional understandings.

[illegible]

Hypothetical Scenario	Classroom Context
TEACHERS ARE ASKED TO GENERATE QUESTIONS IN RELATION TO A **NEIGHBORHOOD WALK** • Can you tell me what you saw on our walk? • Can you tell me how many different sounds you heard on our walk? • What did you observe in your neighborhood? • Name at least three moving objects you saw in your neighborhood. • What did the trees look like in your neighborhood?	DURING CIRCLE THE TEACHERS DISCUSS **TRANSPORTATION**, THE FOLLOWING IS AN EXCERPT FROM THAT CONVERSATION. Teacher: "How can we move around the street?" Several children respond, "car." (The children generally answer in a group during this exchange.) Teacher: "How many wheels does a car have?" Most say four. Teacher: "How else can we move around the street?" Several answers are heard and the teachers pick out and affirm, bus, motorcycle and truck. Teacher: "A truck has how many wheels?" Several numbers are heard. Teacher: "What does a motorcycle have that a bus doesn't have?" Many don't respond. One child says, "has keys." Teacher: "What are the keys for?" Same child: "To start it up." Teacher: "What does it start up?"... "What makes a bike go?" Several children respond, "the wheels." Teacher: "What makes the wheels go?" A few say, "the pedals." ... Teacher reviews, "So we can use a car, a motorcycle, a bike, a bus, our feet to get around the city. Where can I go in my boat? ..." (Fieldnotes 4/28/97)
TEACHERS ARE ASKED TO GENERATE QUESTIONS IN RELATION TO A **NEIGHBORHOOD WALK** • What kind of sounds did you hear? • Can you name some things that take us from one place to another? • How did it feel outside? • Did you see any occupation workers? • What did you see? hear? smell?	DURING CIRCLE TIME THE CLASS HAS READ *THE LISTENING WALK*. LATER IN THE MORNING, THE TEACHERS TAKE THE ENTIRE CLASS OUT FOR A **NEIGHBORHOOD WALK** "There is not a lot of talk encouraged on the walk. At one point the children stop in awe of construction that is going on. There is a silent pause. [The assistant teacher] suggests they cross the street to observe by a fence. The lead teacher rejects this idea. There is no discussion with the children about the construction site: The children peer silently for a moment longer, and then the group moves on. ... a couple of children get excited about the horse-drawn carriages they're seeing. 'Horsy. Horsy.' The teachers do not follow up on this excitement." (Fieldnotes 4/22/97)

[illegible]

Hypothetical Scenario	Classroom Context
TEACHERS ARE ASKED TO GENERATE QUESTIONS IN RELATION TO A **BUBBLE BLOWING ACTIVITY**. • What happened to the water now that we added soap? • What's different about it? (taste, smell etc.) • What do you think will happen if we blow into the cup through this straw? • What happened? Why? • Why did one person only make a little bit of bubbles and others made a lot? • How did the bubbles feel?	THE FOLLOWING DISCUSSION TAKES PLACE BETWEEN A TEACHER AND TWO CHILDREN WITH WHOM SHE IS WORKING ON A PAPER-MACHE, **RECYCLING** PROJECT. The teacher comments to Mary, "You are liking this!" The child nods, and the teacher says, "Imagine if you walked through it? How would it feel?" Mary doesn't respond, just keeps on squishing and smiling. Teacher: "How does it feel?" Mary: "Cold ... It feels like lotion." She pretends to lick it off her hands. Teacher: "You're just pretending, right? But it wouldn't hurt you if you did eat it. It's just flour and salt and water. But it wouldn't taste good." The next child comes up for a turn. ... As this child gets more comfortable dipping the newspaper into the paste and placing it on the mold, the teacher remarks that the paste "looks like pancake batter. I wonder what would happen if you made pancakes out of it?" The boy makes a face, "Oooo, It's slippery." He adds, "Oooo, my hands messy." Teacher: "Yes, but you know what? You're washable." (Fieldnotes 4/10/97)
TEACHERS ARE ASKED TO GENERATE QUESTIONS IN RELATION TO A GROUP OBSERVATION OF **A FISH TANK.** • What makes the bubbles in the water? • Where do they come from? • What other kinds of animals live in water? • What do you think would happen to the fish if they get out of the water? • Why can fishes live in the water and we can't? • Do you think they can hear us? Why or why not?	CHILDREN ARE OBSERVING WHAT THEY HAVE COLLECTED WHILE **EXPLORING THEIR PLAYGROUND**. A boy starts, "What kind of things you found?" The teacher continues, "What did we find a lot of?" She repeats her question several times, then asks differently, "What did we find a lot of especially on Marco's?" The first child responds, "papers and cigarettes." Teacher: "So what can we say about the people who sit near the playground?" A girl: "Smoking." Then another girl right after, "Smoking." ... Teacher: "What would happen if they [people] never threw the trash in the trash? ... think of people smoking cigarettes and eating candy and throwing it all on the ground." Marco stands up to demonstrate how smokers crush their cigarettes in the ground. A girl adds in, "you might die" [because it would start a fire]. Marco: "Nuh, uh, you can run." ... The discussion goes on for a few moments until the teacher redirects: "What would happen if everybody threw all their garbage in the trash?" The children, however, continue discussing fire. (Fieldnotes 4/17/97)

In addition to illustrating differences between survey responses and actual classroom questions, the preceding chart highlights the importance of classroom context for understanding the full meaning of the teacher's questions. When read out of context, the question looses some of its meaning and intent. Creating a climate of inquiry was a process which teachers often dipped in and out of, in their effort to balance their theoretical endorsement of children's exploration and discovery with ingrained habits of many years and archetypes of teaching. This was visible throughout Ms. Johnston and Ms. Rivera's efforts. Ms. Rivera was struggling with that very issue when she said, after many staff development sessions, "I still can't ask open questions. What are they?" When the researcher, present suggested that Ms. Rivera's own questions about the turtle that day were prime examples of open questions, it proved a turning point for that teacher. Her own experience with her own real question allowed her access to a deeper and real life understanding.

- As teachers' knowledge and experience grew, space and time for science and math in classroom life expanded; the tone of the classroom invited both teachers' and children's discoveries. This was seen in different forms and to differing degrees in each of the classroom stories in the Prologue and Chapter Two. The director of the parent-child center also made a similar observation at a focus group in May, 1996. She said that she had seen a lot of teacher directed activities before the kits came into use; "Now, ... the children are more free to experiment. ... the teachers [are] letting them experiment. ... [teachers] value efforts instead of the end product. ... I see the children as being more able with less direction from the teachers." The director of Head Start also endorsed this view, " ...[teachers] are experimenting, which I don't think they were before. They are not afraid to have anything growing or not growing. I don't think they did too much of that before. Now it looks like a [plant] nursery."

- As children entered more fully into the science choices available in their classrooms, their visible interest and excitement was reciprocal and further encouraged teachers' commitments. Teachers reflected this pleasure in children's learning and its influence on them during interviews and focus groups. Teachers asserted that the children could see when their teachers were really interested in their responses and this further stimulated children's interests in science: "By us being more motivated, that motivates them and they all want to say something." Additional evidence is seen in the survey previously referenced, in which RFA asked Cohort One teachers to rate influences on their science and math teaching. The item rated first as a primary influence was children's reactions and interest in the materials (*See Chart IIIc*).

Implication: Projects that attempt to continue investigation into ways that adults can explore children's discovery and encourage their curiosity and inquiry are needed. Perhaps eliminating the word <u>question</u> from use altogether and considering the word <u>comment</u> or <u>observation</u> in its place might be helpful. Encouraging other kinds of action that teachers might take, such as standing back and observing details of children's exploration before speaking, deciding to put additional materials close at hand, or designing a follow up activity which draws upon knowledge that children have shown interest in pursuing further are other options. Video tapes of classroom events followed by in depth discussion of teachers' possible actions or reactions could also be useful.

Projects that engage teachers in authentic adult inquiry are likely to encourage those teachers to transfer their excitement into classroom practice. Such practice, in turn, appears to impact children positively. Working with teachers to recognize the possibilities and interests in which both teachers and children share curiosity may be productive, if elusive. In this project, we have seen that very young children's learning is closely tied to their teachers' interest, commitment and enthusiasm.

CHILDREN'S LEARNING

V. CHILDREN'S ACTIVITY IS THE BEST INDICATOR OF WHAT THEY MAY BE LEARNING. Children's eager choice of science activities and materials was strongly referenced in the first section of this chapter. When materials were presented within classroom structures that encouraged play and discovery, children could be counted upon to "dive right in." RFA developed a hypothesis for their learning which suggests that it is circular and spiral, rather than linear. At ages three and four, boundaries that adults may see between active or fantasy play, social interaction, and content hardly exist. In this project we saw children playing and becoming familiar with science and math tools and materials, and thus learning something about the processes and characteristics of science and math. Children drew what they had experienced, or talked about experiences to friends. They varied and invented new play, and as time went on exhibited some degree of mastery, knowledge and control over tools and materials. We saw this, for example when the child in the story, "*It's Set Up...And The Kids Just Carry On*" repeatedly weighed and then made "popcorn" out of counting cubes, or in the same classroom when a child pretended that binoculars were "cameras." Children's drawings of a bubble activity, examined during a professional development session in April 1996, showed the range of knowledge the children had about blowing bubbles. Liquid, straws and people were depicted in primitive but understandable relation to one another. Children also reported what they knew to their parents, who in turn told teachers. Teachers frequently said parents were their best indicators of what children were absorbing.

- Teachers reported that children enjoyed repetition of science activities and asked frequently for those they liked to be done again. This was first mentioned during a focus group discussion in 1996. During an interview with two teachers some months later, the researcher questioned them about repetition, and one of the teachers responded, "they like it." The other teacher said, "If they like it, they'll ask to do it." The first teacher then expanded: "They build on [a previous experience]. They help one another ... another child might bring in something [else] and they build from that." Later the researcher asked, "How do you know that a child likes something? One of the teachers responded, "They play with it. They play with it all the time."

Teachers reported that children repeated exploration of materials or activities in imitation of a teacher's demonstration, sometimes showing or telling one another how an activity or material worked. This was observed by a researcher in April 1997 in a classroom where a teacher gathered a small group of children and used successively finer sieves to clean muddy water. While the teacher was busy with a second group, the first group went to play at the water table, completely independently. They used various containers and did lots of pouring, but then two girls said they were "doing a water project," in imitation of the teacher's experiment. Another girl joined them, and they shook water in a plastic egg, asserting that it was "dirty water." A fourth child reached for a basket on the window sill nearby and poured the "dirty" water through the basket in order to "clean" it, pretending that the basket was a sieve.

Implications: Young children's learning is most possible when they are given opportunities to be active, to experiment and discover, and to play. Providing good quality materials and support for teachers to provide such play are also critical elements. Building a sound, developmentally appropriate framework offers the best opportunity for the natural ability and wonder of children to flourish.

Some Indications

RELATIONSHIP BETWEEN SCHOOLS AND THE MUSEUM

This final section of Chapter Three is presented as a set of indications. It comes from meetings and interviews with the museum staff over the course of the project, as well as understandings from other museum personnel on other science projects with which RFA has had contact.[15]

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[15] RFA has conducted evaluations on two science projects, one with Science Learning Network and one with the Franklin Institute's Museum To Go Kits. Conversations on this topic of school ad museum relationships have been held with Elsa Bailey, doctoral candidate in this field at Lesley Graduate School of

The culture gap between museums and schools is wide. Building bridges across the two, understanding the contrasts and locating the similarities, is challenging. Promoting increased professional relationships between youth museums and educational settings was a goal for this project. Therefore, the complexity of the relationship merits examination.

Museum staffs tend to be more transient. Often museum staff has expertise in given content areas and thus may be more aware of specific material development and use. School faculties, in contrast, tend to be more stable and to have as their major focus entire classroom and school needs. Unless a museum project has a staff person with school experience, who is assigned solely to establish working patterns between school and museum, bridging the culture gap that exists between the two is extremely difficult.

In today's museum world, it is not unusual for program staff to be hired for a particular project, to therefore be newer at their work, and have much less classroom experience than the more seasoned teachers, who are often chosen for special projects. Furthermore, a great deal is expected of the museum professional, who although extremely knowledgeable about his/her content area and usually filled with eager commitment, may not have all of the professional skills required to support new ideas and new approaches in large school systems and schools with experienced teachers.

Realities of schools today suggest that teachers are busy every moment keeping their classrooms, curricula, and day to day needs afloat. Thus, the ideas and materials that the museum may be introducing, though much desired, are not usually at the core of the teacher's work. This is in contrast to museum educators for whom these materials are the core of their work; the project is often the very purpose for which the individual on the museum staff was hired.

<u>Museum staff has many roles to play. Different skills are required for each of these roles.</u> In this project there was insufficient time for the small museum staff to learn and execute all of the tasks involved, though they made tremendous efforts and did manage to complete most of them with good results. The project educators had to locate and evaluate materials,

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Education, Molly McLaughlin of the Franklin Institute and Sukey Blanc, Research Associate at Research for Action.

write teachers guides, design the staff development, spend time in classrooms, plan and staff family events and attend to marketing questions, all of which were part of the original proposal.

Some aspects of the museum educator's role in this project were especially difficult. For example, training teachers and writing teachers guides are professional career skills, usually developed over extended time, often requiring advanced study and experience, yet it was expected that these tasks could be undertaken by the museum educators. Because the kits assumed a hands-on, constructivist approach, museum educators were often required not only to present new content material to teachers, but also to introduce them to new ways of thinking about teaching and learning. This would have been a daunting task for even experienced professional developers. It was a double challenge for the museum educators in this project.

It was difficult for museum educators to follow the recommendation that they spend time in classrooms where the kits were placed. There is an understandable tendency for museum based staff to stay within areas most familiar to them, i.e. within the museum, rather than in the schools or out in the larger community of parents and families. Informal discussion and inquiries of museum staff in other cities reveals that this is a pattern. As the project progressed, the project educators, who had originally remained within the museum, saw value in classroom visits, which contributed to their understandings of how to work with teachers. Given their scheduling constraints, however, the educators were not able to spend any significant amount of time in classrooms. It seems crucial that project educators get into schools when materials and approaches are being developed. This may help bridge the culture gap that exists between museums and schools. One institution could learn from the other and thereby mutually enhance joint projects undertaken.

Given the hurdles the museum staff has had to overcome in Science All Around Us, they have nevertheless accomplished some very important first steps toward the establishment of a consistent, developmentally appropriate, and materials based science approach for early education.

Implications: Future projects that involve schools and museums, might find it useful to recognize the need for a staff position especially funded and designated as in-school and site based. Ideally this might be an individual with considerable experience in teacher training. This person could then develop a substantive partnership with schools and teachers, create continuity, and develop a supportive and reliable relationship between the museum and the school.

Chapter Four—Family Involvement

Family involvement was part of the original proposal for this project and was an early commitment of Science All Around Us. RFA's research confirms what Please Touch Museum staff and other project partners already know: family involvement is a difficult but important task that requires much thought and innovation. This section discusses some of the learning that the Science All Around Us project offers in this area.

Efforts made to involve families fall roughly into two categories: Outreach by the museum and outreach on the part of schools through teachers (and children!). Museum outreach evolved over the course of the project. During the pilot phase of the project, Family Events at the museum as well as smaller family workshops on site were tried. From 1996-1998, project educators conducted Family Events for participating classrooms at the museum and gave free memberships to all families who were part of the project.. As RFA's formal evaluation of the project draws to a close, PTM's continuing development of Science All Around Us includes additional exploration of family involvement strategies, such as backpacks of books and activities to be sent home with children on a rotating basis. (These recent efforts were outside of the scope of this study.) Outreach on the part of schools varies from site to site; however, at all sites teachers and directors consider family involvement a priority, and they are trying to include the PTM project as part of their outreach.

Museum Outreach

I. FAMILY LIAISONS WERE HARD TO ESTABLISH WITH DEPTH OR CONSISTENCY. Throughout the project family involvement remained peripheral. Insufficient time and resources were key factors hampering PTM's efforts in this area. The project faced the same struggle that centers in general face with regard to families. Obtaining the participation of families challenges deeply entrenched trends and realities and requires great and sustained efforts. As the director of the parent-child center put it, part of the challenge is that "school has traditionally been an area in which parents showed up when their children were in trouble," so the process of embracing parents, of saying "come on in and help in the classroom," means that "educational programs, no matter what they call themselves, need to do a better job of coming together to send the message as a group of how important it is to have family involvement with school. Therefore, they won't be hearing from just a few of us, but they will come to know the home and the school as being almost one and a continuum."

- Over the course of the project, museum educators devised increasingly successful formats for family events. Nevertheless, even when successful, such events affected only a select group of parents, those willing and able to come to the museum. Science All Around Us made efforts to include families by arranging Family Events on site and as class field trips, and by giving project families free one year museum memberships after the first year. Attendance at Family Events was significantly higher in the 1996-1997 school year than it had been the year before. When interviewed at family events, parents, including those at the event described at the end of *Does He Have a Heart?*, expressed pleasure at the opportunities made available in this way. Many families, however, fell outside of this loop. Families could not take time off during the school day for trips, or had young siblings at home who could not be accommodated on school transportation. As one director pointed out, parents have their own pressing priorities:

  > "Some parents are struggling with training, trying to find jobs. Others are preoccupied with other serious family issues, and stuff that we have planned is just low on the totem pole of priorities, and that's it. Some people just struggle for basic needs, and they really don't see the things we provide for them as being important." (Fieldnotes June, 1997)

- The time and personnel to address the creation of substantial family liaisons was severely limited, though more resources were allocated in the final eighteen months of the project. Museum staff members found themselves faced with many difficult and competing tasks as they fabricated kits, planned professional development and worked to include families in the project. Up until the last year, the tasks of developing kit materials and professional development were prioritized. In the 1997-1998 school year, when more resources were allocated to the work of involving families, some research into the literature about family involvement was initiated, and an intern was hired expressly to explore more options that would lead to greater family participation.

School Outreach

II. FAMILY PARTICIPATION IN THE PROJECT WAS CONNECTED TO THE LEVEL OF FAMILIES' PARTICIPATION AT THE SITE IN GENERAL. It is notable that the schools themselves had difficulty making family connections, even though Head Start programs require them. In the parent-child center, where family relationships were already well developed, family relationships with the project were stronger.

- The extent of parent involvement varied from site to site; however, when there was parent involvement at a site, parents did not seem to be asked to participate in science activities in the classrooms. The parent-child center site appeared to have more family involvement than the other centers: for instance, researchers saw at least one family member volunteering in the "*Does He Have a Heart?*" classroom in five out of six visits, from February through May, 1997. These family members were often observed to be engaged in classroom activities, including one child's aunt who came frequently. Many family members from this center also came to Family Events at the museum that year. Researchers, however, saw little or no evidence of these volunteers involvement with science.

  At an interview in the spring of 1997, a Head Start director suggested that one remedy to this lack of involvement would be to give parents specific help and direction in leading science activities. She pointed out that assistant teachers in the Head Start classrooms are all parents who have been trained to do a variety of school activities that they had not previously done.

In the "*We Don't Worry About Making Mistakes*" classroom, where the teachers frequently spoke of their disappointment in the extent of family involvement, the Parent Scholar seemed to be getting some exposure to open science exploration simply through her daily presence in the classroom. On several occasions, researchers observed the Parent Scholar being pulled into explorations of kit materials by eager children. Such spill over while encouraging does not always challenge the preconceptions about science that the project wishes to replace, as seen in the following description from a researchers notes.

> Ms. Barkley [the parent scholar] sees Jessica looking at the snails and reaching toward them. She says to her, "No don't touch it. If you do, you have to wash your hands." She quickly puts the top on the cage. (Fieldnotes February, 1997)

Such hesitation was still evident with this Parent Scholar at the end of the year:

> Nearby Ms. Marks is working with the children in pairs on making a bubble cup. The children are pretty excited with all the bubbles they can blow through a soapy cheese-cloth. I hear Ms. Barkley tell her son not to get any ideas. They are not making that at home ---too messy. (Fieldnotes May, 1997)

Teachers at this site were either unaware of the parent scholar's statements and feelings or had not managed to work with her concerning her reluctance for children to handle animals or deal with "mess."

- <u>Despite some beginning steps, the majority of parents in the project did not have much involvement with or awareness of science in the classroom</u>. For instance, in the 1996-1997 school year, at all but two sites, researchers did not see parents at all. Moreover, several parents, spoken to in classroom contexts, were unaware of the museum project. The director with whom we spoke, in the Spring of that year, was also unaware that one of the project goals is to get parents to do experiments with their children in their homes using household materials.

- At some sites, the Science All Around Us project provided a rallying point to encourage family involvement. The Day Care Center, described in *It's Set Up ... And The Kids Just Carry On*, used the Science All Around Us project to encourage parents' interest in their program. Teachers at this site saw the project and science activities as a unique entry point. In the Cohort Two classroom at this center, efforts included starting a parent newsletter in which they offered some of the science activities as well as assigning "homework." The children were asked to pay attention to the sounds they heard on their way home, "like in the book supplied with the kit, *Listening Walk*," and to get their parents to help them write down three sounds they noticed.

  Researchers in this classroom also observed on more than one occasion that the notice sheet of activities provided to parents included science activities such as, "a peanut butter play dough made with peanut butter, honey and powdered milk" and a "counting tree rings" activity which took place at circle time. As one researcher noted, "those parents who read this information would be well informed about what will happen or has happened in the room." Telling families about their center's involvement in the PTM project as a way of attracting parents to the classroom was a center policy. Ms. Daniel remarked at a focus group that their orientation meeting for parents incorporated the fact that they "were involved in this [PTM project]. I think ... it's something that will capture parents' attention."

Child Outreach

III. THE MOST SUSTAINED EFFORTS AT INVOLVING PARENTS CAME FROM A RATHER UNEXPECTED SOURCE, CHILDREN: PARENTS HEARD AND LEARNED ABOUT EXPLORATORY SCIENCE ACTIVITIES FROM THEIR CHILDREN. In interviews and at focus groups, teachers reported that through their children, parents and families were learning the most about science. One teacher put it this way:

> If the children are well informed about the different materials and how they work and what you do with them, they are the ones who go home and really help to get the parents involved because then they insist on wanting to do different things or go different places to see different things --outdoor walks looking for rocks, you know things that we do in class. I think that they are one of the main keys to getting to the parents.

She went on to say that teachers usually don't have much contact with parents as they briefly drop their children off or pick them up at the end of the day. Thus, while much of this knowledge overflow from the classroom to the home took place outside of view, teachers were aware of its importance.

At least some parents were also aware of this phenomena. One of the parents whom RFA interviewed in May 1996 commented about how what was going on at school was seeping into her home.

> 'Cause even with the pets that they have in the classroom, my daughter never liked those bugs and stuff. Now, she comes home, "Oh mommy, I think we should get the little silkworm. We should get some fish." I said, "I'll think about it." (Fieldnotes May, 1996)

Her comments resonated with that of the other parent interviewed at that time, who said that her child had learned what floated and what didn't at school and now tries it at home in the bathtub. Such transfer was also seen in the subverted cookie-making activity and the other parent's knowing smiles in "*Does He Have a Heart?*"

Implication: Without significant resources specifically directed toward the effort of involving parents, it is not realistic to expect that a new project can easily accomplish a task that is already problematic within schools. Again, in a future project of this nature, a specific staff position seems indicated. Although the work of involving parents may at times feel daunting, it is an important task. When parents are aware of their children's educational setting and curriculum, they are better able to support the child's growth and learning.

Chapter Five—Conclusion

This report summarizes three years of the development and implementation of a major science project for three and four year old children, Science All Around Us. Please Touch Museum developed this project, which resulted in four interconnected and comprehensive science kits, accompanied by professional development, and tested in a range of Head Start and day care classrooms. During piloting and planning stages, the museum reworked the project often and made adjustments in their own staffing and that of the schools with which they worked. Although museum staff were unable to spend significant time in classrooms, the kit materials as well as the curriculum and its organization all impacted positively on children's science learning. Please Touch Museum was rigorous in gathering information about teachers' opinions and uses of the kits. They acted upon these opinions and the recommendations that emerged from RFA's research, enriching the museum's original vision of Science All Around Us, and extending the possibilities of young scientists' learning.

Related family involvement initiatives were also implemented in this project. These efforts showed promise, however, PTM staff had many demands upon its human resources and their ability to pursue in depth approaches to family involvement was limited. The result was less opportunity to try various possibilities and to determine what might be most effective.

Finally, the success of curriculum and materials, of teachers' pedagogy, of classroom tone and children's learning, were all positively influenced by the Please Touch Museum staff, most importantly the museum educators assigned to this project, who had to assume many roles and had to bridge the culture gap between schools and museums. The expectation that a small museum staff would be able to fulfill these many roles was probably unrealistic. Nevertheless, the project educators undertook their many tasks with energy and commitment; they accomplished a great deal and are to be commended for that.

Research For Action carried out formative and evaluative research during three phases of the project, a planning phase, a pilot phase and a consolidation phase. Research on the successes and challenges of the kits is documented with extensive data on children's and teachers' activities, as they used the materials which the museum provided. Two overarching issues can be seen throughout this research.

The first issue is one of time. Time came up repeatedly in regard to teachers' understandings and classroom experiences. Given enough time to reflect, share and develop ideas, the large majority of teachers found ways to implement the project successfully. Children needed time as well, time to make the unknown more familiar through play and early experimentation, and time to express their learning through language and a range of activity.

The other key issue was the role of teachers. Every section of the findings in this report carries the imprint of teachers' work. Teachers and their perceptions were of central importance as they set the stage for young learners. Teachers' efforts to adapt materials and teaching approaches is detailed in depth in the case studies of four classrooms, as well as in the findings, which also discuss professional development. Teachers were free to choose the materials they presented, and they decided how that presentation would happen -- through formal lessons, by simply making materials visible and available, or by some combination of both. To that end, the materials proved themselves flexible, developmentally appropriate, and suited to a broad curriculum base.

Teachers set a climate and tone for children which, in most classrooms, encouraged exploration and discovery in science. Verbal and nonverbal questions were asked. A reciprocal effect inspired both teachers and children, who were drawn to the experiential activities that the Science All Around Us project invited. As children became excited and appeared to be learning, teachers also became excited and motivated to do more. Children's learning was visible through their play, their behavior with materials, in their responses to teachers, and in their reports to their parents.

Current focus at the museum now includes marketing decisions, an integral part of the original proposal. Research for Action has been involved only minimally in this marketing phase of the museum's work; however, RFA strongly endorses the concept that good science and math materials, organized in a kit format, and accompanied with children's books, create highly valuable opportunities for science and math discovery and experimentation in early childhood classrooms.

Professional development accompanying such kits is also crucial. It provides an essential opportunity for teachers to learn together, to share the project developers' insights and suggestions and to develop personal understandings of the content and approach embodied in the kits. Professional development also helps keep teachers' focus on the project in the classroom.

RFA is hopeful that Please Touch Museum will succeed in locating a distribution network that will advertise and include all of these essential aspects of the project. This is a critical next step in making good quality science education more available in early childhood classrooms.

APPENDIX A: Calendar of Research Events

Calendar of Major Research Activities

Spring 1995

- Focus Group Discussions

  Directors and parents of Head Start and Day Care Centers participating in project

  Experienced teachers with science teaching background who were not to be participants in project.

  Teachers identified as Cohort One participants in the project

- Baseline Observations of all five Cohort One classrooms

- Observations of prototype materials in museum gallery

Fall 1995--Winter 1996

<u>Cohort One teachers and classrooms</u>

- Administration of Pilot Survey to Cohort One teachers
- Focus Group discussion with teachers
- Observations of professional development sessions
- Observations of Cohort One classrooms to see Kits in use
- Initial interviews with all ten Cohort One teachers
- Materials Checks and discussions of materials in each Kit

NSF Project Advisory Group

- Observation of advisory group meeting
- Focus Group discussion with project advisors

Families

- Observation of museum based Family Event

Spring 1996

Cohort One teachers and classrooms

- Continue observations of Cohort One classrooms to see Kits in use
- Continue observations of professional development sessions
- Focus Group discussion with teachers
- Interviews of teachers
- Materials Checks and discussions of materials in each Kit
- Administration of Pilot Survey to Cohort One teachers

Families

- Observations of Family Events at school sites
- Interviews with selected Parents at school sites

Directors

- Focus Group discussion with directors
- Interviews with selected directors

Fall 1996--Winter 1997

Cohort Two teachers and classrooms

- Administration of Survey to Cohort Two teachers
- Initial observations of selected Cohort Two classrooms to see Kits in use
- Interviews with selected Cohort Two teachers
- Materials Checks and discussions of materials in each Kit
- Focus Group discussion with teachers

Families

- Observation of museum based Family Event
- Interviews of selected parents at Family Event

NSF Project Advisory Group

- Observation of advisory group meeting

Spring 1997

Cohort Two teachers and classrooms

- Continued observations of selected Cohort Two classrooms to observe Kits in use
- Interviews with selected Cohort Two teachers
- Materials Checks and discussions of materials in each Kit
- Administration of Survey to Cohort Two teachers

Cohort One teachers and classrooms

- Observations of selected classrooms
- Interviews with selected teachers
- Focus Group discussion with all Cohort One teachers
- Administration of Survey to Cohort One teachers

Families

- Observation of museum based Family event
- Observation of selected Family Events at school sites
- Interviews of selected parents at Family Event

Directors

- Focus Group discussion with directors

Fall 1997--Winter/Spring 1998

Cohort One teachers and classrooms

- Continued observations of selected classrooms
- Reunion Focus Group with all Cohort One teachers

Cohort Two teachers and classrooms

- Continued observations of selected classrooms
- Materials Checks and discussions of materials in each Kit

NSF Project Advisory Group

- Observation of advisory group meeting

Families

- Observation of museum based Family Event
- Interviews of selected parents at Family Event

Museum

- Interviews with museum staff

APPENDIX B: Examples of Interview and Focus Group Protocols as well as Field Guides

RFA 12/4/96

Interviews with Teachers

First Interview

There are several areas to gather information about. These may not all come up during first interview and can carry over into next interview(s).

PERSONAL

1. What has your own background in teaching been? What led you to teaching? To this job?

2. What led you to participate in the PTM Project? Selection by others? Self selection/choice?

CLASSROOM

1. What is schedule of the day/week? Does it vary?

2. What has science been like in the classroom -- before the kits, currently, future?

3. Demographics of the classroom

    Who are the children? Bilingual? ESL?

    How many adults?

4. What is important to you for the children in your classroom?

    What do you like to see children doing? (touch on social interaction, language, questions, use of materials)

5. How do you know when children are learning?

    If you have a child very interested in science, how would you describe what s/he does?

6. What is the nature of Parent Participation?

Interview Guide Teachers

The major purpose of this interview is to continue to discuss the perceptions of the teachers about the kits and the children's interactions with them.

A second purpose is to continue to tap teachers' understandings and perceptions of:

science in their classrooms - space; activities; planning; surprises
language and questions
their own roles as science teachers

Some of the interview should focus on what was observed in previous visits, especially in regard to the above areas. Interview notes should include observations about whether teachers' perceptions appear to match (or not) the observational fieldnotes. In what ways?

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1. The interview should begin with an open question regarding what thoughts the teachers have about science at this time.

2. Interviewers should make every effor to continue a teacher's line of thinking and to encourage techers to relate incidents or thoughts that spring to mind.

3. Interviewers should keep the above topics in mind and listen for the teacher to include them in the discussion. When they do not come up, interviewers should frame some questions that might probe for this information, such as:

   What are some recent activities you have done that you think were especially good?

   What has not worked out as well as you thought it might?

   What would you like to do that you haven't had time for as yet?

   Do you see children returning to activities? In what ways? Which activities?

   What is important to you for the children in your classroom?

   What do you like to see children doing? (touch on social interaction, language, questions, use of materials)

   How do you know when children are learning?

4. Be sure to include some discussion of parent involvement.

QUESTIONS FOR DISCUSSION
11/16/95

1. Please jot down the 2 or 3 most used materials, or materials that you are most excited about in your classroom.

AND

Please also jot down the 2 or 3 materials that are used least, or that haven't worked out.

After you've hadtime to think and jot a few notes, we'll go around the table and share what you've thought of.

2. Thinking back to the notes you made earlier, or something that was prompted by the conversation we've just had, would you identify a specific incident, or a time that was exciting in your classroom -- related directly or indirectly to the Tool Box or Our World Kit?

AFTER COLLECTING PEOPLE'S IDEAS, GROUP THOSE THAT SEEM TO FALL TOGETHER, ASK PEOPLE IF THIS IS WHAT THEY HEARD, AND IF THERE ARE FURTHER THOUGHTS ABOUT THESE EVENTS. WHAT MADE THEM IMPORTANT OR EXCITING?

3. Now we're going to switch gears, and think for a little about the professional development sessions. Can you name something that went on during these sessions that was especially useful or stimulating?

POSSIBLE TO AGAIN GROUP IDEAS AND HAVE FURTHER DISCUSSION IF TIME PERMITS.

Mixtures and Changes
Focus Group with Teachers
3/12/96

1) Materials checklist and comments to be completed by teams of teacher and assistant teacher (if present). 15 minutes

2) Question: Think of an activity or material associated with the Mixtures and Changes kit that stands out for you. Describe in some detail what you did and what the children did with it.

After descriptions:

3) Talk about what you think this activity added to your classroom - to the children's knowledge/learning experience.

4) Further Probe:

Summarize what teachers have said.
Refer to two characteristics that came up in the last focus group:
children like to manipulate things, have an effect on things
teachers' enthusiasm is important as a support to activities

Are there other characteristics that you have heard in today's descriptions - yours or others' that you think are important as we think about children's learning?

5. Description of Drawings

Teachers will be told that these drawings were collected in one of the classrooms in the project. They will be asked to look at the several drawings as a body of work and describe what they see in them. Following descriptions and discussion, teachers will be asked what recommendations they might make to themselves as a result of the discussion about the drawings.

Movement and Motion Focus Group with Teachers
5/8/96

1) Materials checklist and comments to be completed by teams of teacher and assistant teacher (if present). (15 minutes)

(As teachers work on this, perhaps make interview appointments. 2choices)

2) Because we see classrooms briefly, it's unclear to us how the Teachers Guides have been useful to you. Can you look through the guide and identify the ways your teaching has been influenced by it. (20 minutes)

3) Children's enjoyment of repetition came up strongly in our last Focus Group discussion. Again, we see the classrooms briefly so, can you think about this most recent kit and describe how repetition came about? Were the repeated activities planned/spontaneous/both. Be as specific as possible. (20 minutes)

4) Several teachers have pointed out concerns about children's verbal responses in instructional settings, for instance when you have asked a question at circle time or during a small group activity. What do you think contributes to their difficulty with language? (20 Minutes)

Probe: Do you notice children speaking more at some times than at others?

5) We see teachers as co-constructors of the curriculum as they work with the PTM kits. We are conscious that it is difficult for you to get feedback from us. And we feel worried about that.

We come into your classrooms with our Please Touch Agenda and Our Field Guide for observation. Sometimes we have a few moments with teachers for discussion, sometimes not. When you are very busy, we hesitate to intrude. Are there ways you would like to get feedback from us? Are there aspects of our visits that are easier or more difficult?

Focus Group Questions
12/97

Gathering of Cohort I to See Where They Are This Fall

It has been several months since we last met, and this is the first year that you are without any direct support from PTM.

This is a special opportunity that we have to interview you about the results ad spinoffs of your involvement in the Science All Around Project. And, as we promised, we'll also try to give you some of the flavor of the report we prepared for PTM on last year's work.

1. Could we go around the table and hear from you about your thoughts of science as you began this year?

2. What have been the outcomes of that thinking? Give some specific examples.

3. What are your thoughts about science in your classroom this winter and spring?

4. What might you show a visitor from NSF who wanted to see evidence in your classroom of the benefits of the project?

5. What will be hard and what will be easy about continuing science activity in your classroom this year and in future years? What might happen?

PTM Science and Math Project
Focus Group Questions
Pre-School Directors
May 8, 1996

Welcome, introductions, and review of purposes of this focus group--to learn from their perspective as directors about the kinds of contributions they see the PTM kits making to classrooms, teachers, children and parents. Review procedures for the focus group (i.e. important that everyone contribute, taping, length of time we have, etc.)

1. Through your contact with and observation of classrooms, what changes, if any, can you see as a result of participation in the PTM project? Please tell us how frequently you visit classrooms and have opportunities to see the kits in action (or other ways you have for learning about what is happening in classrooms). Please describe changes in terms of before and now.

Probe in terms of teachers, children, parents, curriculum, instruction, classroom structures

2. In what ways, if any, has participation in the PTM project gone beyond a classroom and effected the center as a whole?

Probe in relation to purchase of materials, new curriculum, teacher sharing

3. Do you have any suggestions for changes or adjustments to the way in which the project was conducted this year for next year?

Probe in relation to kits in classroom, parent involvement, professional development

Interview Questions for Directors 5/97 RFA

1. Have you had the opportunity to visit any of the PTM classrooms?

what impressions?
follow up with any probes related to what they say -- what do they mean by something? an example? etc.

2. What has stood out for you about the project? What have you especially noticed?

3. Have you noticed any changes in the PTM classrooms? (May come up in above two).

4. How do you see the PTM project fitting/not fitting into other aspects of your program?

5. Have PTM teachers shared their work with others?

probe for specific examples

6. What is your view of parent involvement at the site? With PTM in particular?

Interview With Parents/ Family Members
May 1996

Teachers were invited to arrange interviews of a half hour with parents or other adults who had participated in PTM Family Events or volunteered in classrooms. Groups were suggested.

The interview is intended to open the door to discussion, especially to research what draws parent/family interest.

Question to be posed by interviewer:

What (PTM) Family Events have you attended? / Classroom activities have you assisted with?

Your questions are especially helpful as we work to think about next year.
Do you have any questions about the activities at the Family Events?

Do you have any suggestions for future events?

Do you have any questions or comments about the classroom activities?

PLEASE TOUCH MUSEUM SCIENCE AND MATH PROJECT RFA 4/96

Field Guide for Fourth Round of Visits to Partner Centers Movement & Motion

The purpose of this fourth round of site visits is to further test observation and assessment procedures. This round will coverthe two classrooms which were not visited during the third round of visits.

These visits will focus on: Classroom environment; time structures; child behavior and activity; and teacher activity and interaction with the children.

We want to pay particular attention to language, questioning and evidence of knowledge construction. These visits are part of a data collection effort which will include information from kit training sessions, teacher focus groups, teacher surveys and family events.

Observation Protocols

1. Physical space and access

--is there a designated science table or area in the room? Are there bulletin boards, parent announcements, other physical evidences of science in the curriculum?

--what is availability and access to tools and kit materials (see attached lists)?

*which tools and materials are on shelves or tables and available as children wish to use them?

*which tool and material use is directed or controlled by the teacher?

2. Time Structures

--how much time is allotted to free activity with the materials?

--how much time is the teacher presenting ideas/materials from the kit or related activities(e.g. discussion, class projects, other)?

--is there a change in amount of time allocated for science?

3. Children's Activities

--see attached chart of possible children's activities

--note any other activities that relate to children's use of the kit & tool box

-- pay particular attention to children's language use and questions (spoken or otherwise indicated)

--how are children using tools? Designated purpose? Other?

--what processes are children engaging with?

investigating? revising and retrying? transferring information and tool use? Other?

--is there evidence that children are working to make new things more familiar?

--are children repeating activities?

4. Teachers' Activities

--see attached chart of possible teacher implementation activities

--note any other activities that relate to science ideas in the curriculum and/or to the use of the kit & tool box

--pay particular attention to teachers' questions (e.g.) the manner of response, the language used, the kinds of questions asked

--note any teacher comments related to personal knowledge construction or observations of children and/or activities

--note time spent in science activity with group of children/ individuals

--is the teacher pointing out, or raising children's awareness of the framework: changes, similarities and differences; connections?

--is there evidence that teachers are using familiar language materials and activities in relation to science?

Assessment Categories

OUR WORLD

CHILDREN'S ACTIVITIES

USING TOOLS	EXPLORING	OBSERVING AND REPORTING
(Most of the activity in this column and the next column - Using Tools and Exploring - will be indepencent child activity or teacher assisted child activity)	By observing, feeling textures, making rubbings, drawings, magnified observations, children might:	*(Much of this will be from teacher observations obtained from interviews journal notes: / progress notes)*
measuring and comparing plant growth	-compare & contrast rock, wood samples, insects	reporting of behaviors in the EXPLORING category
using magnifiers to look at wood, rocks, other items in kit	-see similarities & differences in rock samples, tree samples, animals, natural objects	documenting changes, such as plant growth (a camera is suggested as best visual representation for this age child)
using thermometers and relating to weather	-spontaneously sort objects by characteristics	sharing charts or books made during discussion times
collecting natural objects in petri dishes	caring for/observation of animals	sorting & pattern making activities planned by teacher
	engaging with objects in kit over time	discussing different plant growth mediums and how that affects plants
	asking questions	discussing different animal habitats
	naming objects in the kit	spontaneously repeating demonstrated activities
	bringing collections of other objects into the classroom	
	personalizing, making up stories about objects in kit	
	seeing relationships between and among objects in kit	

Implementation Categories

OUR WORLD

TEACHERS' ACTIVITIES

USING TOOLS	EXPLORING	OBSERVING AND REPORTING
facilitating children's tool use by:	facilitating children's explorations by:	facilitating and keeping records of children's explorations and observations by:
modeling correct tool usage	knowing when and when not to intervene	observing and reporting children's behavior
supporting & assisting children's tool use in alignment with NCTM standards:	- providing wait time	documenting comparative behavior over time
- suggesting appropriate tools which might help children's understandings at appropriate times	knowing how to intervene	working with others to draw conclusions from data
- non standard units of measure	- asking open ended questions	linking observations to what goes on in the classroom - making teaching decisions based upon these observations
- using comparative language rather than numerical language	using language freely, frequently	
	-discussing what children are doing	
	-spending time in general conversation about children's interests or observations	

PROJECT GOALS AND ACTIVITIES FOR CHILDREN * PLEASE TOUCH SCIENCE PROJECT

The expected outcomes when children develop scientific literacy from these experiences are:
Improvement of knowledge, attitude & comfort levels with science and math; stimulation of curiosity; sustained learning.

CHILD ACTIVITIES	PROJECT GOALS			
	DEVELOPMENTALLY APPROPRIATE	ENGAGING FOR CHILDREN	OPPORTUNITIES FOR SCIENCE DISCOVERY	OPPORTUNITIES FOR CONSTRUCTING KNOWLEDGE
COGNITIVE SKILLS				
Encourage children to ask questions	X	X	X	X
Discuss possible answers	X	X	X	X
Develop accurate vocab.	X	X		
Count Objects (up to 5)	X	X		
Identify geometric shapes	X	X		
Quantify (one/many)	X			
Discuss & record results of observing (dependent upon developmental abilities)				X
PROCESS SKILLS				
Observe	X	X	X	X
Sorting (by 1 characteristic)	X	X	X	X
Hands on experiences with authentic tools, artifacts, materials	X	X	X	X
Experiments		X		X

PROJECT GOALS & ACTIVITIES FOR TEACHERS * PLEASE TOUCH SCIENCE PROJECT

This chart suggests some outcomes as teachers are involved in kit training and kit classroom interaction with children

TEACHER ACTIONS	PROJECT GOALS			
	IMMERSE TEACHERS IN SCIENCE DISCOVERY	ENABLE TEACHERS TO HELP CHILDREN CONSTRUCT KNOWLEDGE	ENABLE TEACHERS TO BECOME OBSERVERS OF CHILDREN AS LEARNERS OF SCIENCE	ENABLE TEACHERS TO DOCUMENT CHIDREN'S GROWTHINSCIENTIFIC KNOWLEDGE
PROFESSIONAL DEVELOPMENT				
Develop educational resources	X	X	X	X
Increase knowledge of science content areas and national trends	X	X	X	X
Enhance skills in using materials in instruction	X	X		
Enhance the design and maintenance of science materials	X	X	X	X
SUPPORT TO CHILDREN				
Support children by asking open-ended questions that promote critical thinking	X	X	X	X
Adapt kits into instructional routines	X	X		
Emphasize learning as an interactive process	X	X	X	X
Provide multi-disciplinary education	X	X	X	
Integrate science & other aspects of curriculum	X	X	X	X

Observations of Children

Assessments and narratives of children individually and in groups will be examined for evidence of the following characteristics,* among others.

Interest

Some indicators: Time spent on activity; repetitions of activity; focus on activity; other

Discovery - of process, of content knowledge

Some indicators: Questions, statements both spontaneous and prompted;
actions exploring relationship; other

Pleasure/Excitement

Some Indicators: Facial expression; wish to involve or be involved with others; direct statements; other

Imaginative Play; Manipulative Play; Active Play

Some Indicators: Handling, using material alone, involving others or joining others;
Spontaneous or guided play; other

Observations will take place in classrooms before kit distribution, during kit use, following kit use and at the end of the project.

*See sources below for further description:

Bredekamp, Sue and Rosegrant, Teresa (eds.), *Reaching Potentials: Appropriate Curriculum and ASsessment for Young Children, Volume 1.* NAEYC, 1992
Holt, Bess-Gene, *Science with Young Children.* NAEYC 1989

1/97 RFA

Follow Up Visits to Selected Cohort Two Sites

Refer to the format of Initial Visits (11/96 RFA). Also incorporate these additions.

1. Physical Space -
   Note changes, additions or deletions with particular attention to science materials.

2. Access -
   To what degree and at what times are children able to use science materials independently?

3. Kit Materials -
   When new kits have come into the classroom, to what degree and in what contexts are they made available?

4. Activities -
   Focus on science related, large and small group as well as independent.

5. Language -
   Continue to note questions and discussions related to science

APPENDIX C: Survey Instruments

TEACHER SURVEY FOR COHORT II
PLEASE TOUCH MUSEUM
SCIENCE AND MATH PROJECT

LAST FOUR DIGITS OF YOUR SOCIAL SECURITY NUMBER __ __ __ __

YOUR SCHOOL SETTING

Please check one

Head Start Affiliated with Public School System___
Head Start Affiliated with an Independent Agency___
Day Care or Other Center ____

YOUR POSITION

Lead Teacher___
Assistant___
Other (Please Specify)________________________________

YOUR DESCRIPTION

Male___
Female___
Race, Ethnicity ________________________________
Age: 20s, 30s, 40s, 50s, 60s (Circle One)
Years of Teaching Experience _____
Years In Present Position _____
Years of School Completed ____High School ____College ____Graduate Degree
Other - Please Specify ________________________

YOUR CLASSROOM - MATERIALS AND ACTIVITIES

1. How do you introduce new materials in your classroom? **(For each item put an X in the space that represents how frequently you do the following.)**

	Never	Sometimes 1-3x/wk.	Often 4-5x/wk.	Not Sure
By showing them to the whole class first				
By showing them to a smaller designated group				
By making the material available as a choice without teacher assistance				

Comments:

2. How often are there opportunities for children to independently explore new materials? **(Circle one.)**

Never **Sometimes (1-3x/wk.)** **Often (More than 4x/wk.)** **Not Sure**

3. To what degree do the following activities (most often teacher-led), spark enthusiasm/excitement in your classroom? **(Put an X in the space that represents your description. If you do not have a particular activity in your classroom, put an X in the N.A. [Not Available] space.)**

	N.A.	Minimal or None	Moderate	Often	Not Sure
Reading Aloud by Adult					
Songs					
Action Games					
Outdoor Play					
Art					
Science					
Other(specify below)					

4. How often do you see children using the following materials? **(Put an X in the space that represents your description. If you do not have a particular material or activity in your classroom, put an X in the N.A. [Not Available] space.)**

	N.A.	Never	Sometimes	Often	Not Sure
Books-Factual					
Books-Stories/ Poems					
Water Table					
Magnifiers					
Balance Scales					
Paint					
Science Table					
Natural Objects (such as shells/seeds)					
Computer					
Plants					
Animals					
Sand Table					
Other(specify below)					

5. What science or math projects did you do this past year (cooking, body and senses, plants, etc.)?

6. What science or math tools and materials were on your science table/shelf this past year? **(Put an X on the space that indicates the extent of their availability, or put an X in the N. A. [not available] space.)**

	N.A.	A few Days	More than 10 Days	Through the Year
Magnifiers				
Natural Objects (like shells, rocks, leaves, seed pods)				
Small Animals				
Balance Scales				
Thermometers				
Timers				
Magnets				
Measuring Cups				
Measuring Tape				
Others (specify)				

7. What is your estimate of the number of children in your class who used or played with these items? **(Put an X to indicate your estimate. If you did not have the material, skip that space.)**

	A Few	About Half	Most
Magnifiers			
Natural Objects (such as shells, rocks, leaves, seeds)			
Small Animals			
Balance Scales			
Thermometers			
Timers			
Magnets			
Measuring Cups			
Measuring Tape			
Others (specify)			

8. How would you assess children's purposes in their use of materials and tools ? **(Check all that apply in the space next to each material or tool. You may check more than one for any item.)**

	Play	To Find Out Something	To Carry Out a Teacher-Directed Task
Magnifiers			
Natural Objects (such as shells, rocks, leaves, seeds)			
Small Animals			
Balance Scales			
Thermometers			
Timers			
Magnets			
Measuring Cups			
Measuring Tape			
Others (specify)			

YOUR CLASSROOM - QUESTIONS AND CONVERSATIONS

9. How frequently do you do the following with your children? **(Put an X in the space that represents the frequency of the following conversations.)**

	Never	Sometimes	Often	Not Sure
Talk to them about the work they have completed.				
Talk to them about something they are currently handling or playing with.				
Engage them in group investigations.				
Engage an individual child in an investigation.				
Help them investigate questions they bring to you.				

10. Thinking about the kinds of questions you ask children, are they... ? **(Put an X in the space that represents the frequency of the following questions.)**

	Never	Sometimes	Often	Not sure
Things you hope most children have learned.				
Things you think only a few children may know.				
Things you think children may be interested in hearing more about.				
New ideas you want to introduce?				

Other kinds of questions you might ask, or your comments.

11. Please read the following brief classroom descriptions and respond to the questions below each one.

A. **A NEIGHBORHOOD WALK**

Your class has gone on a neighborhood walk. The children are back indoors, gathered in a circle.

What question or questions might you ask to begin a discussion?

B. **A FISH TANK**

This year you have a fish tank in your classroom. In the first three days that it is set up, you notice that three children in particular have been watching it.

What question or questions might you ask them?

C. **MIXING THINGS**

A group of children are gathered around a table with you. Wet and dry edible ingredients are in the center of the table along with mixing utensils. Each child has a small mixing bowl.

What question or questions would you ask before the children begin to mix the ingredients?

You now tell the children that they can mix the ingredients together. All of the children's mixtures are different from one another.

What questions might you ask now?

D. **A BALANCE SCALE**

You have put a bucket balance scale on a table along with small blocks, small toys, a few large blocks and some rocks. A child stands at the table and begins to load both of the buckets with the rocks.

What question might you ask the child?

E. **BUBBLE BLOWING**

You are sitting with a group of 5 children at a table. There is a small pitcher of water and a squeeze bottle of liquid detergent on the table. Each child has a cup and straw. You tell each child to fill his or her cup half way with water and to add a few drops of detergent.

What questions might you ask the children before they go any further?

Each child takes a straw and blows into the mixture. Bubbles erupt. Some children blow a few big bubbles. Some blow mountains of bubbles. Some blow bubbles across the table. Others cover their hands with the bubbles.

What questions might you ask the children now?

12. How frequently do children come to you with... ? **(Put an X in the space that represents your estimate.)**

	Never	Sometimes	Often	Not Sure
Questions about an event in the classroom.				
Questions about materials or material use.				
Questions about social situations.				
Math or science related materials they have brought from home or outdoors.				

13. Rank the following questions from 1 to 3. The number 1 should represent what you do most frequently and 3 less frequently.

	Rank 1 (most) 2, or 3 (less)
One on one conversation with individual children.	
Conversation with a small group of children.	
Conversations with the whole group.	

YOUR OTHER THOUGHTS AND IDEAS

14. How well do you think you handle the following? **(Put an X in the space that describes your best estimate.)**

	Excellent	Good	Fair
Spontaneous math and science opportunities in the classroom or on field trips (such as the appearance of an insect or other surprising occurrence).			
Talk with children about their interactions with science materials.			
Construct open ended science questions for children.			

15. How comfortable are you teaching other staff members about science or math related materials or ideas? **(Circle your answer.)**

Very Comfortable **Reasonably Comfortable** **Somewhat Comfortable** **Uneasy**

16. Please respond briefly to the following 2 questions.

What are some successful ways to encourage children's questions?

What activities did you do in the past year that you found most useful in encouraging science related skills, such as exploring, observing, questioning.

Materials Survey

This excerpt from a materials survey for materials in My Body and Science shows the way each material was listed under one of the categories in the kit.

Teachers were asked to work with their classroom teaching partner to fill this form in for each item in the kit, including books.

This survey was accompanied by a focus discussion related to teachers' reactions to materials.

Research for Action 5/97	**Please comment about the following tools and supplies included in the My Body & Science Kit**			
(Revised Kit)	Frequent Use	Infrequent Use	No use	Further Comment
Water Splash!				
squirt bottles				
sponge brushes				
funnels				
pipe cleaners				
clear tubing				
bubble soap				
bulb syringes				
oil				
baking soda				
salt				

Science All Around Us™ Themes	SCIENCE KITS			
	My Body & Science	**My Home & Science**	**My Community & Science**	**My World & Science**
WATER SPLASH!	Properties of Water	Plumbing	How We Keep Water Clean	Rivers and Ponds
GOOD VIBRATIONS!	Musical Sounds	Home Sounds	Community Sounds	Nature Sounds
WHAT CHANGES?	Human Growth and Changes	Cooking and Nutrition	Building Construction	Weather
NATURE'S EXPLORERS	Five Senses	Gardens & Weaving	Trees and Recycling	Bugs & Worms
MOVE IT!	Kinesthetics	Simple Machines	Transportation	Animal Movement & Tracks

Questions for Materials Response Discussion 5/13/97

Kit: My Community and Science
Cohort II

1. First impressions of the kit. What materials did you try? What did you like and why? What didn't you like? Did you try all materials?

Pick up on specifics from above responses if appropriate. More detail.

2. You were given an alternative Teacher's Guide during the professional development session that came after your first exposure to this kit. What differences did you notice in the two guides? What made one more useful than the other (If this is what is indicated)? In what ways?

3. How did this kit fit into other things you are doing in the classroom? (Are they an "add on" or do they work into other curriculum?)

Get specific examples.

4. Give two examples of questions you like/ questions that you think have helped children learn.

5. In what ways are children expressing their discoveries?

6. How are you assessing children's growth and learning?

7. What materials in this kit do you think have helped you connect math and science activities?

APPENDIX D: Hypothesis of Young Children's Learning

Hypothesis of Young Children's Learning

Research For Action developed a hypothesis about young children's learning. The hypothesis used young children's activity and behavior as a lens for looking at the ways children form knowledge.

Young children's learning is circular and spiral rather than linear. It may include the following behaviors:

Thinking/Talking About/Drawing Tools Materials and Actions

↓ ↑

Repeating Play and Activity, both Imaginative and Process Related

↓ ↑

Varying and Inventing New Play and Process Related Activity

↓ ↑

Exhibiting A Degree of Mastery and/or Knowledge by

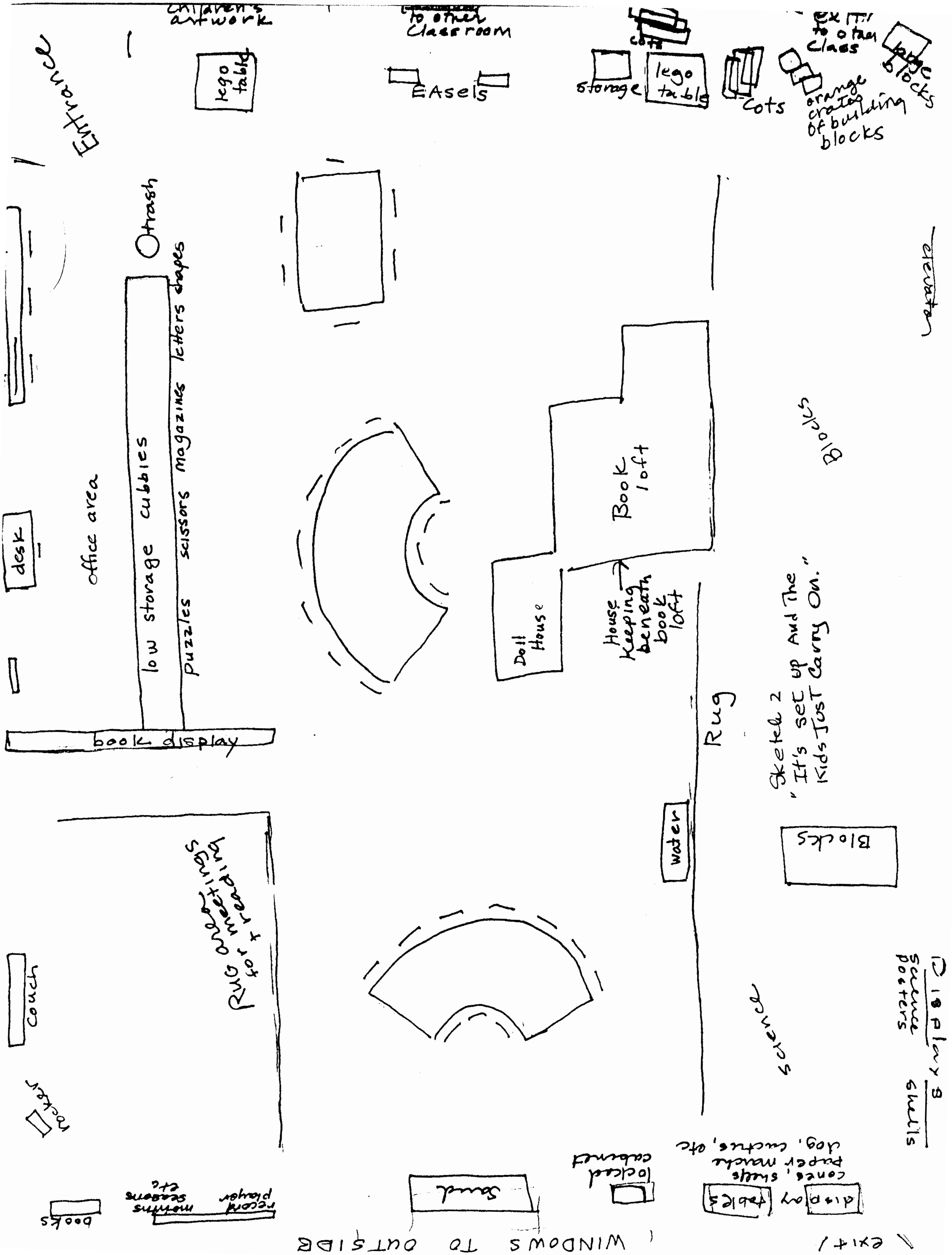
Talking and Representing Thoughts

or

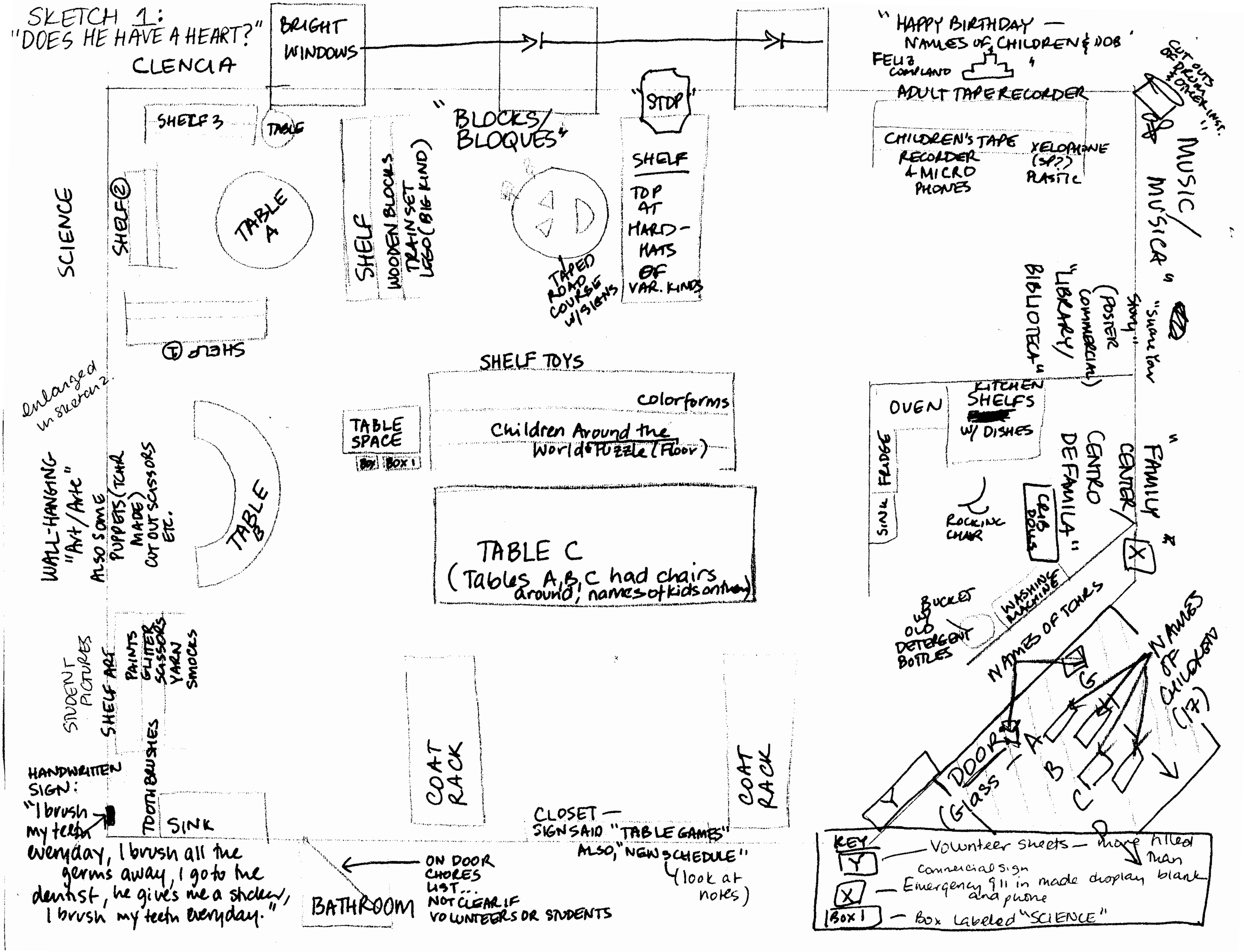
Repeating Activities which may be

familiar
learned
newly invented

APPENDIX E: Classroom Maps



children's artwork
to other Classroom
exit to other Class
cots
lego table
storage
lego table
Easels
Cots
large blocks
orange crates of building blocks
Entrance
trash
low storage cubbies
puzzles scissors magazines letters shapes
office area
desk
book display
Book loft
Doll House
House Keeping beneath book loft
Rug
Blocks
Sketch 2
"It's set up And The Kids Just Carry On."
water
Blocks
RUG area for meetings + reading
couch
rocker
science
Display Science posters
Display shelves
display tables
cones, shells paper mache dog, cactus, etc
locked cabinet
Sand
books
months seasons etc
record player
WINDOWS TO OUTSIDE
exit


SKETCH 1:
"DOES HE HAVE A HEART?"
CLENCIA
BRIGHT WINDOWS
"HAPPY BIRTHDAY — NAMES OF CHILDREN & DOB"
FELIZ COMPLANO
CUT OUTS OF DRUM & OTHER INST."
ADULT TAPE RECORDER
CHILDREN'S TAPE RECORDER & MICRO PHONES
XELOPHONE (SP??) PLASTIC
MUSIC/MUSICA"
"Show tow Story"
(POSTER COMMERCIAL)
"LIBRARY/BIBLIOTECA"
SHELF 3
TABLE
"BLOCKS/BLOQUES"
"STOP"
SHELF
TOP AT HARD-HATS OF VAR. KINDS
TAPED ROAD COURSE w/SIGNS
SCIENCE
SHELF ②
TABLE A
SHELF
WOODEN BLOCKS
TRAIN SET
LEGO (BIG KIND)
SHELF ①
Enlarged in sketch 2.
SHELF TOYS
colorforms
Children Around the World Puzzle (Floor)
TABLE SPACE
BOX
BOX 1
KITCHEN SHELFS w/ DISHES
OVEN
SINK
FRIDGE
ROCKING CHAIR
CRIB DOLLS
CENTRO DE FAMILIA"
"FAMILY CENTER/
WALL-HANGING "Art/Arte"
ALSO SOME PUPPETS (TCHR MADE)
CUT OUT SCISSORS ETC.
TABLE B
TABLE C
(Tables A, B, C had chairs around; names of kids on them)
BUCKET W/ OLD DETERGENT BOTTLES
WASHING MACHINE
NAMES OF TCHRS
NAMES OF CHILDREN (17)
STUDENT PICTURES
SHELF ART
PAINTS
GLITTER
SCISSORS
YARN
SMOCKS
TOOTHBRUSHES
SINK
COAT RACK
COAT RACK
DOOR
(Glass
Y
A
B
C
D
G
HANDWRITTEN SIGN:
"I brush my teeth everyday, I brush all the germs away, I go to the dentist, he gives me a sticker, I brush my teeth everyday."
BATHROOM
ON DOOR CHORES LIST... NOT CLEAR IF VOLUNTEERS OR STUDENTS
CLOSET — SIGN SAID "TABLE GAMES" ALSO, "NEW SCHEDULE" (look at notes)
KEY
Y — Volunteer sheets — more filled than blank
X — Commercial sign Emergency 911 in made display and phone
Box 1 — Box labeled "SCIENCE"