

Underprivileged Urban Mothers' Perspectives on Science

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Abstract: The purpose of this article is to report our findings from a qualitative study intended to develop our understandings of how inner-city mothers perceive science. Using qualitative methodologies, our analysis reveals that the mothers' perceptions can be grouped into four categories: perceptions of science as (a) schoolwork/knowledge, (b) fun projects, (c) a tool for maintaining the home and family, and (d) an untouchable domain. After we present these categories we compare our findings across categories to argue that those mothers who had spent time doing science with their children were more likely to have a more personal, dynamic, and inquiry-based view of science. We also argue that mothers' perceptions of science were more dynamic when they spoke about situations and contexts that were familiar to them, such as food, nutrition, and child care. We conclude the article with a discussion of the implications our findings have for science education reform. © 2001 John Wiley & Sons, Inc. *J Res Sci Teach* 38: 688–711, 2001

When families are involved in their children's education, children earn higher grades and receive higher scores on tests, attend school more regularly, complete more homework, demonstrate more positive attitudes and behaviors, graduate from high school at higher rates, and are more likely to enroll in higher education than students with less involved families. For these reasons, increasing family involvement in the education of their children is an important goal for schools, particularly those serving low-income and other students at risk of failure. (Funkhouser & Gonzales, U.S. Department of Education, 1997, p. 1)

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This excerpt from a recent report issued by the U.S. Department of Education, like many recent reports of the past 5 years, describes the importance of increased participation of parents in their children's education. As many of these reports state, nowhere is this more important than in our nation's cities where poor children are lagging behind their counterparts nationally in math and science achievement. Several recommendations for increased parental involvement have been offered in this and other similar reports, including such things as assigning parent coordinators and family liaisons in schools, establishing homework hotlines, providing child care and transportation services, conducting home visits, holding town meetings for parents to voice concerns, and supporting teacher–parent school renewal teams (Eagle, 1994; Henderson & Berla, 1994; U.S. Department of Education, 1994; Ziegler, 1987).

However, what these reports inadequately consider are how well parents are positioned to enact these kinds of recommendations. For example, do parents have the financial means to take time off from work to attend their child's school? Are parents fluent in English or are school personnel fluent in the parents' languages? Do parents know the culture of power enacted by schools well enough to advocate for their child's needs and rights? Finally, do parents share beliefs and understandings similar to schools about subject matter knowledge and on what constitutes achievement within the academic subjects? We focus our paper on this last point.

The purpose of this article is to report our findings from a qualitative study intended to develop our understandings of inner-city mothers' perceptions of science. Before we proceed, we would like to acknowledge the ongoing debate about what science is and to highlight that, in the report, we are not making any claims as to what science is. Rather, we are focusing on what a select group of poor urban mothers perceive science to be and the implications these mothers' perceptions have for our efforts in science education. To accomplish this task, we first review the literature around inner-city parents and science education. The purpose of this literature review is to highlight the key issues regarding urban poverty and parental attitudes and participation in school-based science activities for children and their families. We then turn to the results of our qualitative study. In this section of the article we describe how the mothers' perceptions of science can be grouped into four main categories: perceptions of science as (a) schoolwork/knowledge, (b) fun projects, (c) a tool for maintaining the home and family, and (d) an un-touchable domain. After we present these categories we compare our findings across categories to argue that those mothers who had spent time doing science with their children were more likely to have a more personal, dynamic, and inquiry-based view of science. We also argue that mothers' perceptions of science were more personal and dynamic when they spoke about situations and contexts that were familiar to them, such as food, nutrition and child care. We conclude the report with a discussion of the implications our findings have for science education reform.

Inner-City Parents and Science Education

Urban Poverty

What we know about families in urban poverty is sobering. Poverty rates in the United States exceed that of all western industrialized countries except Australia (Smeeding & Rainwater, 1995). Single parent–headed families, followed by two-parent families, make up the poorest segments of the population in the United States. Consequently, 21% of all children in the United States live in poverty, and 50% of all urban children hover near the federal poverty line at some time in their lives (Duncan & Rodgers, 1988). Whereas white families comprise the

majority of the poor in absolute numbers, Hispanic and African-American families are over-represented in poverty statistics (U.S. Bureau of the Census, 1992). Furthermore, chronic poverty for African-American families is dramatically evident at both the family and neighborhood levels, especially in urban settings (Duncan, Brooks-Gunn, & Klebanov, 1994). We also know that family poverty and neighborhood poverty are significantly related to developmental problems in children, to poor academic performance in all areas, and to school dropout (Chase-Landsdale & Gordon, 1995).

Little of the published research on families, urban poverty, and schooling has focused specifically within the domain of science education. However, there is a growing interest and research focus involving parents (both urban and non-urban) and science education. The majority of the research focused on parents and science education covers the following areas: (1) connections between urban children and urban parents' experiences in science, (2) attitudes and achievement, and (3) participation. We summarize these findings below.

Connections Between Urban Children and Urban Parents' Experiences in Science

A major national science educational goal is to promote scientific literacy for all Americans. In current science education discourse, this means enabling students to experience the richness of understanding the natural world, to use scientific principles in making personal decisions, engage intelligently in public discourse about matters of scientific and technological concern, increase their economic productivity by being a scientifically literate person, and qualify for a multitude of professional and technical careers. Making central the goal to help all students understand science and to apply science to their everyday lives is important. A growing body of research around science and underrepresented populations (i.e., girls, minorities, and children in poverty) reveals members of underrepresented groups are not scoring as well on high-stakes exams (Kahle & Meece, 1994; Rodriguez, 1997). Furthermore, research in this domain reveals that when science is taught decontextualized from everyday life many students from underrepresented groups feel alienated from school science (Brickhouse, 1994; Osborne & Barton, 1998; Rodriguez, 1997). Although these research efforts have largely focused on children in school science, there is a small but growing body of evidence that these trends hold for parents as well.

For example, Scribner-Maclean's (1996) study shows that many parents believe they do not know enough science to be effective science teachers at home. Another study involving inner-city parents conducted by the Wildlife Conservation Society in New York City indicates that even when poor urban caregivers want to help their children with school science, they do not feel comfortable with their knowledge of science or with their knowledge of how schools work (Belfiore & Barton, 1999). These same studies show that even when such parents do have some knowledge about science and use it to help their children, the school science knowledge the parents possess is often inadequate (or viewed as inadequate) for the purposes of schooling. Furthermore, regardless of the level of subject specific knowledge parents may have, the sheer level of alienation that many parents have toward schools influences their levels of disengagement with their children's (or their own) continuing formal education (Fine, 1991; Patthey-Chavez, 1993; Valencia, 1991; Valdes, 1996). The majority of the parents who feel alienated from schooling are mothers and grandmothers and members of underrepresented minority groups, and live in poverty (Chase-Landsdale & Brooks-Gunn, 1994; Fine, 1991). This is important given that many women and many underrepresented minorities also feel alienated from and uncomfortable in science and science education (Brickhouse, 1994; Rosser, 1985).

Attitudes and Achievement

The attitudes-based research suggests that a positive correlation exists between parent education levels, parent participation in their children's education, parents' own school science experiences, and the child's science attitudes, beliefs, and achievements (Atwater, Wiggins, & Gardner, 1995; Germann, 1994). The Education Trust (1995) also suggests that a correlation exists between parents' and children's attitudes regarding schooling. These reports have highlighted the findings that when parents feel empowered with school and with science, they more readily provide guidance and support in their children's science education. This has been shown to be a particularly important influence on increased student achievement, especially when parents learn to be advocates in standards-based instruction (Educational Trust, 1995; Henderson & Berla, 1994; U.S. Department of Education, 1994; Ziegler, 1987).

Several practical examples of these findings can be found in the research on Family Science and Family Math and other family-based activities such as 4-H. Studies in this area have shown that children learn to do and use science more quickly and confidently when they do science-based activities with their parents at home, especially when the selected activities have direct connections to everyday home-based practices (DeMerchant, Lytton & Lytton, 1995; Dierking & Falk, 1994; Marino & Hammond, 1998; Thompson & Cittadino, 1991). These family-based activities with active parental involvement have also been shown to be particularly important in boosting the achievement and confidence of ethnic minority students (Smith & Hausafus, 1998). What we see as crucially important here is the widescale evidence that participation and support by parents has a positive impact on student achievement and attitudes toward science.

Participation

The third area of research involving parents and science education has focused on the ways in which parents can serve as a resource in their child's science education. However, parental participation in schooling in the inner-city setting is often hindered by transportation, financial resources, material resources, language, and education barriers (U.S. Department of Education, 1997). Despite these limitations, pockets of innovative projects that have attempted to bring teachers and parents more closely together in learning science have met some success.

For example, several studies have documented ways in which teachers can involve parents in their children's scientific and technological discoveries both in school and at home leading to improved understandings on the part of students (Feely, 1994; Fuller, 1996; Geake, 1993). The Lawrence Hall of Science programs bring parents and children together to explore math and science through home-based games (U.S. Department of Education, 1997). Their efforts have led to sustained parental involvement and increased interest in science by students and parents. Some schools have attempted to increase parental involvement by providing computer rooms and hands-on science centers in K-8 schools for family use during after-school times. Although the effect of these efforts has not been thoroughly documented, there are early signs that this positively influences parental involvement in their children's, math, science, and technology education (Funkhouser & Gonzales, 1997). Finally, some efforts have focused on involving parents in curriculum development and science reform initiatives (Geake, 1993).

Although none of these studies examined how parental perceptions of science influence the degree to which they participated in their children's science education, what we see as important in these studies is the documentation of how parents have been able to participate successfully in their child's science education, including helping to design home-based experiences that potentially more forcefully link school science with the home. Also important is the

documentation which shows how these kinds of initiatives open channels of communication between teachers and parents potentially affecting what happens both at home and at school (Fuller, 1996).

We believe that these findings suggest that further inquiry into parents and their perceptions of science is crucial: Current efforts to reshape science education address diversity issues in either the school environment and classroom practice but rarely take into account the needs or expertise that urban parents bring to the science education reform process.

Our Study

The qualitative study presented in this paper is part of a larger 3-year project aimed at better understanding how teachers, students, and parents and university people can better work together to promote improved scientific literacy in the inner-city through curriculum development and teacher and parent professional development. The project, *Linking Food and the Environment (LiFE): An Inquiry-Based Science and Nutrition Curriculum*, has focused on researching, developing, implementing, and evaluating an inquiry-based, hands-on science curriculum for elementary students, their teachers, and their caregivers that allows children to explore life science and health through an investigation of something familiar to them—food and the system that brings them their food. More specifically, during the 3-year program, a 2-year curriculum for fourth- through sixth-grade students was developed that uses the study of food and the food system—from production of food on the farm through food processing and transportation, to effects of food on personal health and on the natural environment in terms of waste and pollution—to address national standards in the areas of science as inquiry; key understandings in life sciences; and unifying concepts such as the relationship of science, technology, and society. In addition, a 2-year teacher development series and parent participation series was also developed and implemented alongside the classroom-based component (Contento, Barton, & Koch, 2000).

In this particular article, we report on our findings from an aspect of our study intended to develop our understandings of how inner-city mothers perceive science. Using qualitative methodologies, our analysis reveals that the mothers' perceptions can be grouped into four categories: perceptions of science as (a) schoolwork/knowledge, (b) fun projects, (c) a tool for maintaining the home and family, and (d) an untouchable domain. Given the low level of participation in science within the poor urban community, this is an important area of research. Low levels of participation and achievement in science by underprivileged urban children are often exacerbated by the role their parents have in education. These parents are typically not involved in their children's education at the level expected by their children's teachers. Although in contemporary popular culture discourse the parents receive full blame for this lack of participation, sociological studies in education have shown us that this is not a fair assessment (Valdes, 1996). Our research, which seeks to understand how mothers of elementary school children in the inner city perceive science and their children's education in science, will provide an important link to finding ways to build stronger partnerships between school science and the home. In other words, if we as teachers and researchers could understand more deeply and thoughtfully how parents in the inner-city urban community think about and use science, we might be able to integrate parental ideas, experiences, and beliefs more successfully in classroom practice. This assertion is supported by research in multicultural science education which suggests that one way to make science class more inclusive is to value the lived experiences of students and their families, especially for those whose experiences are not mirrored in traditional schooling and science practices (Atwater, 1996).

Research Participants

Twenty-four mothers were involved in our study. We use the term *mother* throughout this article, but in fact there were three grandmothers and one aunt. We do so because they were performing mothering roles in relation to the elementary school children in their lives. All of the mothers lived in a large urban area and had children who were currently attending or had attended elementary school in the inner city. We did not intentionally seek only women for this study. However, we were not surprised that only women volunteered to participate in this study given that women overwhelmingly head single-parent families in the inner city (Chase-Lansdale & Brooks-Gunn, 1995). The parents were located through the Parent Organization Coordinators at three elementary schools as well as through fliers sent home with children in these same elementary schools. The majority of the mothers were African American (18); the remainder of the mothers were Latina (6). The mothers ranged in age from the early twenties to the midfifties. Table 1 provides more detail regarding the backgrounds of the participating mothers.

Data Generation and Analysis

To develop the proposed understandings about parents and science, we used four specific data generation strategies. First, we conducted a series of four group interviews during May and June 1998. Each group interview lasted about 2 h. Nineteen of the mothers participated in a series of two group interviews. The group interviews focused on what the mothers perceived science to be, the kinds of science experiences they remembered from when they were younger, experiences engaging in science with their children, and the role that food might have in teaching science to children both at school and at home. A summary of the interview prompts is presented in Table 2. Group interviews were audiotaped and transcribed. The group interview facilitator

Table 1
Demographics and survey data of participating mothers

Race and ethnicity	18, African American 6, Latina
Reported science courses taken (any level)	8, biology 8, nutrition sciences 9, chemistry 4, physics 2, earth science 1, parent workshops 2, other (CPR)
Level of education	1, 9th grade 3, 11th grade 8, 12th grade 3, AAS/Community College 1, 4-yr college/university 8, no report
Age	4, 20–29 10, 30–39 3, 40–49 2, 50+ 5, no report

Table 2

Interview prompts

-
- I. Parent's beliefs and practices about participation in their child's education in school and out of school*
- Talk about some of the experiences you had working with your children science activities such as homework, etc.
 - Some of your science experiences are different. Can you tell me what you think science is? Your own views of what sciences is?
- II. Parent's attitudes and beliefs about schools (science and nutrition teaching and learning) What are the three most important things you want your children to learn or be able to do in school science?*
- How important is science compared with other subjects in your child's school?
 - Talk about your memories of science when you were in school.
- III. Parents understanding of nutrition and science concepts and practices*
- What are your views on using foods to teach science?
 - Try to think back to when you were in school. Do you remember any of the different ways or methods that you were taught to figure out a science experiment? If you do remember, how do you think you use those different ways or methods in your everyday lives?
- IV. Parent's relationships with child's teacher, and school in relation to science education*
- Have you ever helped out at your child's school in any way?
 - Even if you have never helped out before, what are some you might want to help your child out in science in the future?
 - We are going to use food to teach a science curriculum, do you see science and food tied together? In what ways?
 - What kinds of things do you want to learn to help your children with science in school?
-

asked semistructured, open-ended questions to ensure that the mothers felt the freedom and support to discuss the presented topics in their own ways. The questions were asked so as not to interfere with the conversational dimension to the group. Second, during the 1998–1999 school year, we collected detailed participant observer field notes of five of these mothers involved in a 10-part workshop series involving parent participation in school science.¹ These workshops were offered in conjunction with our curriculum development efforts to allow us to learn in rich contextual detail about the science education beliefs and needs of inner-city mothers as well as to offer the mothers opportunities to learn more about our own work. Third, at two different points we conducted a written survey of all participants to learn more about schooling histories, including their level of schooling, place of schooling, age, number of children, and experiences in science. The initial survey was conducted in spring 1998 with mothers who participated in the group interviews. The survey was administered a second time in fall 1998 to mothers who participated in a series of workshops and conversations during the 1998–1999 school year who had not previously completed the survey as part of the group interviews. Fourth, we collected a rich set of field notes from informal conversations with all of the mothers. These conversations occurred before and after group interviews, workshops, and whenever the researchers encountered the mothers in the school. Field notes were coded and analyzed for insights into mothers' perceptions of science.

The purpose of the data analysis was to code the mothers' perceptions of science. We used a process of grounded theory development (Glaser & Strauss, 1967) with the development of specific categories and types being an evolving and iterative process. We used both open coding and axial coding to accomplish this task (Glaser & Strauss, 1967; Strauss, 1987). For example, to code the interviews the authors first read through the interviews and field notes to develop a coding scheme that characterized the responses provided by the mothers in the interviews, their

talk in the workshops, and our informal conversation with them. This initial open-coding process allowed us to break down the data into similar categories, ask questions of and make comparisons between the data and the categories, and develop a set of emergent codes. We then applied this emergent scheme to our complete set of interview transcripts and field notes. In applying this initial scheme, we made constant adjustments and revisions as necessary to incorporate the distinctions that seemed important in the mothers' responses. We also tried combining the open coding in different ways to identify category characteristics, develop propositions, and identify central codes and categories. To ensure interrater reliability we engaged in ongoing conversation about code and category development and critically compared and discussed any analysis work we completed on our own. After the coding categories were developed, credibility checks were conducted to assess how adequately the findings represented what the research participants said (Guba, 1990). These credibility checks were carried out with two parents from similar backgrounds, who did not participate in any of the data collection activities.

Discussion of Findings

In this section of the article we describe how the mothers' perceptions of science can be grouped into four main categories: perceptions of science as (a) schoolwork/knowledge, (b) fun projects, (c) a tool for maintaining the home and family, and (d) an untouchable domain. These findings are summarized in Table 3. Before presenting these findings, we note that categorizing the mothers' beliefs into four discrete groups is problematic. These mothers' perceptions of science are not static and, indeed, some mothers presented us with multiple perceptions of science based on the context in which they talked about science. For example, 6 of the 24 mothers expressed distinct sets of ideas that landed their perceptions in two different categories based on the contexts in which these mothers used to talk about science. We develop and problematize this point in more detail in the subsection, *Border Crossing*, in the Discussion section. Furthermore, as we also describe in more detail below, blurry lines often exist between our defined categories; in other words, there is some overlap between categories. However, we believe the overarching categories reflected by our analysis nonetheless provide powerful insights into making sense of inner-city mothers' perceptions of science. After describing the four categories and providing rich contextual data to support our claims, we compare and contrast these categories to draw out common themes as well as particularities regarding inner-city mothers' perceptions of science.

Science as Schoolwork/Knowledge

The first area of perceptions can be described as science as schoolwork/knowledge. This was one of the two most common perceptions held by the mothers. Ten² of the 24 mothers' ideas belonged to this category. Science as schoolwork/knowledge meant that the descriptions of science provided by the mothers across contexts, including the characteristics, examples, generalities, and boundaries placed on these descriptions were loaded with the language, values, and practices of schooling. In other words, school science—and all of its trappings—was what constituted real science to the mothers in this category. The mothers whose perceptions fell into this category described science through the following composite set of qualities:

- Science is topic- or subject-based (i.e., the curriculum)
- Knowing science is learning or knowing scientific facts

Table 3
Comparison of categories of mothers' perceptions of science

School Based	Project Based	Maintaining the Home	Science is an Untouchable Domain
<ul style="list-style-type: none"> • Topic or subject based (i.e., the curriculum) • Knowing science is learning or knowing scientific facts • Scientific knowledge is static and out there • Science transpires almost exclusively in formal places such as schools or labs • Apersonal • Teacher or text book driven • Loaded with technical language 	<ul style="list-style-type: none"> • Project oriented but topic based • Mainly focused on creating things to demonstrate some sort of phenomenon or generating a product • Dynamic—mothers talked about themselves as part of the process • Transpires any place where people are found • Involves the self but not completely personal • Book knowledge driven but including some elements of personal • Loaded with technical knowledge 	<ul style="list-style-type: none"> • Problem/issue oriented • Focused on daily living and what the mothers needed to know to survive • Dynamic—mothers talked about themselves as part of the process • Transpires in the home/family • Highly personal • Personal knowledge driven, with some references to books • Loaded with experiential knowledge 	<ul style="list-style-type: none"> • Affective negative descriptions of science, including: <ul style="list-style-type: none"> • Science is hard • Afraid of science • Dislike for science

- Scientific knowledge is static and out there
- Science transpires almost exclusively in formal places such as schools or labs
- Science is apersonal
- Science is teacher or textbook driven
- Science is loaded with technical language.

Taken together, these qualities paint the picture of a traditional school science experience rather than any sort of authentic or real-world science. These qualities generate an image of classroom-based activity emphasizing facts, technical jargon, lists of topics, and authority-driven ideas over local understanding that typically has little to do with the work of scientists (Anderson, 1991). Thus, science as schoolwork/knowledge means much more than the mothers simply stating that science to them was a subject learned in school. After all, all of the mothers agreed that science was a school subject, even if they never formally enrolled in school science during their school years.

The mothers who ideas fit this category most often responded to questions such as “What is science,” and “Tell me about a time when you were doing science,” through examples of things they learned about in school such as “[Science is] reproduction. [In science class] we did all those things. We learned about the menstrual cycle, fertilization, and all that.” Even when

pushed to move beyond descriptions of science as school tasks by asking, "Talk about science in everyday life," or "Tell us about doing science with your children," all but 3 of the 10 mothers in this category returned to school connections.³ For example, as one mother responded to the question about science in everyday life, "My daughter, she goes to Jordon elementary school and they do science. She learned that if you cook something the water can't be cold, it has to be hot; when you cook with the cold water it doesn't cook as fast. She tells me that all the time, everyday." Although this mother described a scientific idea common to everyday life, she linked it back to a fact learned in school. In what follows, we present a series of examples to further contextualize science as schoolwork/knowledge.

The mothers who perceived science as schoolwork/knowledge with great frequency described science through lists of topics they studied in specific classes, such as "blood, urine, and bones," or "metals, the elements, magnets," and other topics and ideas learned about in biology or chemistry class. Furthermore, 7 of the 10 mothers in this category described science through specific list of skills learned as part of their formal science courses. For example, one mother, Rita,⁴ described science as "using microscopes" and "dissecting pigs and frogs." Furthermore, she linked her description of science as dissecting and microscopes to assigned school activities: "At first when they told me I had to do it I said, 'no way!' They actually took the heart out of the frog, and you saw it moving! Oooh! I didn't know which was worse, the fetal pig or the frog. That was some experience taking out their organs and put them under the microscope. That was my [science] experience. I didn't particularly care for it but it was something I had to take."

Rita's comments illustrate not only how she tied "science as dissections and microscopes" to schooling, but also how science involved the use of specific technical ideas and language. In introducing her story, she took great care to get out the ideas of dissection and microscopes. In fact, all but 4 of the 10 mothers in this category used a great deal of technical language in their descriptions of science. Rita's description drew on the language of microscopes and dissections. Some of the mothers in their descriptions of science even publicly struggled with their responses to find the right words. For example, when Willetta was asked to describe what science was to her or what experiences she might have had which exemplified science to her, she described her participation in a school-based science workshops for parents: "We did a workshop on the object of what makes things sink what makes things float. What do you call that? [Long pause] Density and buoyancy." When we followed up on her point to learn more about what she meant and why this was science, Willetta expanded her position by describing her own children's participation in these science workshops: "[My children] did volcanoes. They did things with batteries and electricity and things like that." To Willetta, these tasks were science because her children's activities and her own activities could be traced back to science class and science workshops.

Rita's and Willetta's quotations also point to how these school-based perceptions of science are largely teacher or textbook driven. Science, or the knowing or the doing of science, occurred because of an idea or topic the teacher or the textbook introduced to the women. In a more extreme case, Juanita linked her talk about science to activities in which her teacher led her class. As she stated in one of her stories, "The only thing I can talk about is when the teacher was talking about the vapor coming from the pot with the water, the changes for the heat and the vapor!" Like Rita and Willetta, Juanita depended on someone else to make science happen.

Furthermore, the mothers who viewed science as a school subject talked about scientific knowledge as fact-based, and about ideas out there to be learned. By fact-based and ideas out there to be learned, we suggest that these mothers believed that scientific ideas and practices

were developed by others more knowledgeable and then passed on to them. They did not perceive themselves to be active constructors of scientific ideas or processes. For example, all of the mothers' descriptions were based on ideas, topics, or experiences given to them by teachers. Even in the few cases where the mothers described themselves doing science such as in the dissection quotation from Rita earlier in this section, they were doing science not because that was what science was about, but because they had an assigned task to complete. Connected to this point is how these mothers' perceptions of science were apersonal. Their views were linked to books, teachers, and assigned activities rather than to personal interests, questions, ideas, or experiences.

Finally, science as schoolwork and knowledge also embraced the ideas that science only happened in formal places such as schools, school-based workshops, labs, or health-care facilities. All of the mothers whose perceptions fell into this category (except one) described their only experiences doing science in the context of classroom-based activities or learning laboratories. Janet made this point succinctly in describing her own daughter's science experiences: "My youngest daughter does things with beans, but she comes home, takes all my beans, and puts them in water. And I asked her why she wants to do that, and she says she wants to grow flower-somethings that they teach them. [I say] what you do is in school not home!" Janet, like the majority of the mothers whose perceptions largely fell into this group, neatly categorized all scientific activity as happening in schools or school-related functions such as workshops.

Mothers describing science through school-based descriptions is not a surprising finding. In fact, that one subgroup of the mothers overwhelming perceived science primarily as schoolwork/knowledge is supported by the literature about students' views and perceptions of science (Edwards & Mercer, 1989; Lemke, 1990). Students in middle and high schools often talk about science in ways that reflect knowledge as out there, unbiased, and static. They refer to books and teachers and scientists as holders of content. They talk about the discipline through lists of topics and facts.

However, this particular perception of science is important to recognize because of the ways in which such understandings appear to generate separations between those mothers who hold such views and the knowing and doing of science. In other words, our data suggest that mothers who spoke about science in school terms created boundaries between themselves and science. This separation manifested itself in two particular ways among the mothers in this group. The first way had to do with what the mothers knew or believed they needed to know to do science. They did not believe they could do science on their own. For example, these mothers felt they needed to go to school or read a book to do any sort of science. In only one instance did a mother whose perception of science reflected this category draw solely on her own personal, practical knowledge to make a claim regarding knowing and doing science, and even then she only did this once. The second form of separation was affective and had simply to do with enjoyment and comfort levels. All 10 of the mothers whose perceptions reflected school knowledge and work described experiences with science in negative terms. They used words and phrases such as "boring," "hard," "not for me," and "I just gave up" to describe their reactions to science. It was not common for these 10 mothers to use positive language in relationship to science.

Thus, about one third of the mothers in our study perceived science through the lens of traditional school science. They held onto these ideas tightly, tracing any out-of-school science experience or science experiences with their children back to school-based images of and reasons for science. The boundaries these mothers placed around science effectively separated them from science as a discipline and left them with negative feelings toward science.

Science as Fun Projects and Activities

The second category was that of science as fun projects and activities. One fourth of the mothers (6 of 24 mothers) held this perspective. The mothers whose perceptions fell into this category described science through the following composite set of qualities:

- project oriented but topic based
- mainly focused on creating things to demonstrate some sort of phenomenon or generating a product
- dynamic—mothers talked about themselves as part of the process
- transpires any place where people are found
- involves the self but not completely personal
- book knowledge driven but including some elements of personal knowledge
- loaded with technical knowledge.

Similar to mothers who perceived science largely in school terms, these mothers also held fast to book-driven, technically based knowledge with a topic-driven focus. For example, following is a transcript segment from Marena, mother of three children, who, when asked to talk about what science is and any science she might have done with her children, described her involvement in the construction of a shadow box:

I bought a book about science, and we built—I say “we” because I helped [my son] with a shadow figuring a shadow. . . . It’s like a flashlight we had to do it with a flashlight. We build all kinds of shadows. There’s the ghost shadow, the lion and the monkey, all kinds of animals. We cut the papers and build the animal out of the paper and put it on the stake like the lollipop, and then we have put a piece of material in the back like a curved back and then we had to put the shadow in.

Marena’s description about the shadowbox illustrates how she sought outside sources to create a shadowbox. Even though shadows are nearly an everyday experience, it was the outside source of knowledge (the book) which was required for her and her son to generate the idea to do a project on shadows and to find the needed knowledge for construction of the project. Marena described how she and her son found the book, and then were able to pick a project based on what was contained in the book.

In the following quotation, another mother, Marita, described making a volcano with her son. Like Marena’s description, Marita focused on making something and drew from outside sources to do so:

[My son] had, like, a volcano. Now, I didn’t know how to put the way to make a volcano build up. So that was nice. [My child and his friend] did a mountain out of clay and a bottle and there was baking soda, and when they opened it up the whole thing went whoop and they used food coloring to cover the eruption. . . . I had to figure out ‘cause I went to the library and get some books for them, like, how to make the volcano. I mean, it sounds busy but the way my child wants it, like, an explosion,’ cause he wants that.

Like Marena, Marita perceived science as fun projects that required book-based knowledge.

The major differences between perceiving science in school terms and science as projects rested mainly in the reasons for doing science and how the mothers understood their role in that process. For mothers who perceived science as fun projects and activities, it did not matter where

the science actually transpired. Science activities and projects happened in many places including school, home, museums, and the park. In fact, all of these mothers described both school-based and home-based projects and activities. What mattered to these mothers was that they or their children were engaged in some sort of project such as growing beans with and without soil, making shadowboxes, building volcanoes that ooze or explode, and building and maintaining compost boxes. For example, in the quotation that follows, one mother, Celeste, responded to a question about when the mothers had observed science by describing a project about growing plants she had done with her daughter: "I'm building something with my daughter, with the beans in the cup." She described how they followed the instruction to use "dirt" and "water," and that they "did not know how long" it would take for the plants to sprout ("Maybe 1 week, 2 weeks, or 1 month; I don't know"), but that they would "find out" together. As Celeste illustrated, unlike science as schoolwork/knowledge, in which science was viewed largely as a topic and a nondynamic activity, science as fun projects and activities was ultimately about doing. In other words, science was dynamic—the mothers talked about themselves as part of the process. Celeste, like Marita and Marena, was involved in creating something with her child. This was true for all six of the mothers who described science in these project-based terms.

This point about the dynamic nature of science is an important distinction. Many of the mothers in our study described helping their children with science fair projects or project-based homework. However, we believe that simply helping a child with a project did not necessarily mean that the mothers perceived science as a project-based activity. Many of these mothers just saw the doing of science fair projects as another assignment consisting of school-based knowledge. As one mother put it, "Little Brandon did a science project for the fair. He brought it to my house and I still can't remember what it is. He did it with another kid in the school and he got really upset." What we believe to be significant distinctions are the ways in which the mothers described their role in constructing scientific ideas and scientific things when they were helping their child with an activity. As Marita, Marena, and Celeste all illustrate with their comments, each had a formative role in doing science projects and activities with their children.

Science as projects or activities also meant a focus on creating things to demonstrate some sort of phenomenon or to generate a product. In the quotations provided above, both Marena and Marita were active participants in the construction of the shadowbox used to demonstrate how shadows worked and the volcano used to model what volcanic eruptions look like. In the next quotation, in response to a question about doing science with her children, one mother described an activity involving bread, yeast, and balloons: "We were making bread and how to right the bread. [We] also had the yeast with a balloon over a bottle, so it took the amount of time that the bread takes to rise and while the balloon was full with air that was the amount of time it took the bread to rise. It was nice. I did it with my daughter and the balloon got very big." In this example, like many of the descriptions provided by the mothers in this category, science as fun projects was about building or making things that demonstrated some sort of scientific phenomenon. This quotation, like the ones above, also illustrates how these mothers perceived science in project-based terms with their own participation in these projects as central to that definition.

Finally, all six mothers whose perceptions fell into this category expressed positive feelings toward engaging in projects. They used words such as "interesting," "fascinating," and "exciting." Although these mothers also used words such as "a lot of work" and "a challenge," these words were largely in a positive context, to suggest that despite the difficult nature of the work, there was still a positive reward for having accomplished something.

Thus, one fourth of the mothers in our study perceived science through the lens of doing fun projects and activities. For these mothers, science moved beyond school-based visions. Although these mothers still held tightly to the ideals of topic-based, book-driven, technical language, they

did integrate some personal knowledge and interest with a focus on projects that demonstrated phenomena or scientific ideas. Most important, however, they perceived their role in science as dynamic. They could be involved actively in doing science and those activities could happen in many places besides schools.

Science as a Tool for Maintaining the Home and Family

On occasion I will go by the basic rules of measuring. But as far as seasoning and cooking it, no, I'll go by my own instinct. I know what it's supposed to taste like. (Pattie, May 1998)

In this opening quotation, this particular mother was responding to a question about some of the "science things she has learned with food." In a conversational tone, this mother turned to the other mothers in the group interview and described her own improvisations with cooking and how she needed to use her own instinct. We begin this third category of mothers' perceptions of science with this quotation because we believe it captures some fundamental issues about the third distinct way in which some mothers perceived science: as a tool for maintaining the home and family. About one third of the mothers (9 of 24) involved in our study firmly perceived science in this way. We use the phrase "science as a tool for maintaining the home and family" to refer to a vision of science that contained the following characteristics:

- problem/issue oriented
- focused on daily living and what the mothers needed to know to survive
- dynamic—mothers talked about themselves as part of the process
- transpires in the home/family
- highly personal
- personal knowledge driven, with some references to books
- loaded with experiential knowledge.

Mothers and grandmothers in the inner city run the families; they provide emotional support, they cook and clean, and they bring in the money (Chase-Lansdale & Brooks-Gunn, 1995). A great deal of their attention goes to making sure the home runs smoothly. That is not an easy task when money is scarce, the streets are unsafe, and space is limited. Thus, it makes sense that one way in which some of the mothers perceived science was as a tool in maintaining the home and the family.

Maintaining the home or family projected science as a tool for problem-solving daily activities and for survival. To mothers whose perceptions of science fell into this category, science served as a tool for many different kinds of dilemmas or problems, including such things related to family life including cooking, such as knowing how to select good meat from the store, knowing how to check for expiration dates on food and what to do when you find expired food in the store, and knowing how to plant and garden your own food. For example, as one mother, Jackie, stated when asked about science in her everyday life, "[I] want to see if [the food] is good. With meat, I smell the meat to see if it is good. . . . [I] have to find out if the supermarket put the wrong date and or if they mixed in the bad food with the good food."

Science as maintaining the home also included understanding personal health and hygiene such as knowing how and where to clean, how to comb and wash hair, and, finally, knowing what to do when a child gets sick. For example, one mother said, "When you measure the rice, okay, when the family is so big you know how to measure the rice, but when family moves, we are only

two now, you have to know how much water, what to cook.” Science as problem solving also covered the domain of taking care of the house as a physical plant including such things as knowing how and when to change light bulbs, fix the toilet, or figure out how to make the shower work the way you want. For example, Wanda described some of the science she has to know and do when she cleans house: “Being careful of what you mix. Being careful not to mix bleach with ammonia because of the fumes.”

What we believe to be more important than these topics or problems related to maintaining the home described by the mothers were the qualities of science embedded in these mothers’ descriptions. To the mothers in this category science was problem and issue oriented with a focus on daily living, what they needed to know to survive, or how to respond to the curiosities their children presented to them. Like Wanda’s description of mixing cleaning agents and Jackie’s description of checking food expiration dates above, science was also personal, dynamic, and loaded with experiential knowledge, although these same mothers drew on occasion to references or book-based knowledge. For example in the quotation that follows, Pattie described a doll house she built for her daughters:

Well, this last project I was building a doll house, I got stuck with the lights and furniture, but when it got to making the lights go on I couldn’t get them to work. I got stuck, so we were basically reading books about how to make electricity do lights. That took about a month but in my house we do that.

Although Pattie clearly drew from book-based knowledge, she did so in a way that helped her solve the problem of how to build her doll house. This is different from reading a text on electricity and modeling demonstration experiments after diagrams in the book. She sought out what she needed to know to complete the toy she was making for her children’s entertainment.

In this next example, Miki described her need to fix her toilet. In our first meeting with a group of five mothers who were to participate in a yearlong workshop series, the mothers had been describing their perceptions of science. In this conversation the mothers had been listing different topics they considered science. One mother departed from the tenor of the conversation to describe how she fixed her toilet. She described how it was backed up, how she did not have the money to afford a plumber, and how her apartment superintendent was always slow returning work calls. She then told us how she took the top off her toilet, figured out how it worked, found a string for the inner cavity chain and made her toilet work once again. With her rich detail she had the whole group laughing. This example showed how Miki perceived herself as an active user of scientific ideas and ways of thinking. She used her personal problem-solving skills to make her life more livable.

Miki, like Pattie, Jackie, and Wanda, used science in their daily life to solve problems that related to daily living. More important, mothers who expressed this perception of science presented themselves and their actions as central to the science used to solve that problem. Jackie described how what she did to determine whether meat was good to eat. Pattie described how she worked her way through building the doll house for her children. Their science activities occurred in the home-based activities, whether in the bathroom, grocery store, or kitchen. They used personal experience (but not at the complete expense of book-based knowledge) and seemed to see science as an integrated activity in their daily lives, not as a separate topic to be learned or mastered for some abstract purpose.

Thus, one third of the mothers in our study perceived science through the lens of maintaining the home and family life. These mothers viewed themselves as active users and producers

of science. In fact, there seemed to be a shift in power dynamics present—these mothers decided when and how they were going to use science to make their lives easier. They seemed easily to integrate book knowledge with personal knowledge, and the results of their work were almost always highly personal. In other words, science served them instead of their serving science.

Science as an Untouchable Domain

Finally, there was a small subgroup of mothers who perceived science as an untouchable domain. Three of 24 mothers belonged to this category. These mothers rarely described science in anything but affective terms. To these mothers, science was hard. They did not like it and they did not get it. They were afraid of it. Although mothers in other categories may have used the same affective descriptions (see science as schoolwork/knowledge in particular), what caused us to generate this fourth category of perceptions was that regardless of the questions we asked (i.e., What is science? Describe some of your own science experiences. Do you work on science with your children) or the forum in which they were asked (i.e., group interview, personal conversations), these mothers did not, or perhaps simply would not or could not, provide any other description or detail regarding their view of science. It may be that these mothers did not feel particularly comfortable with us and thus were reluctant to provide any more detail. This is certainly a limitation in this data set and analysis. We will not go into detail about these mothers' views of science because they spoke the least and we believe we have few data to support our claim more fully. However, we believe there is power in what they chose to share and in their decisions to leave their public statements with such terse accounts.

Discussion: Building Bridges Across Science

Thus far, we have argued that the mothers' perceptions of science in our study can be grouped into four categories: science as schoolwork/knowledge, science as projects and fun activities, science as a tool for maintaining the home and family, and science as an untouchable domain. When we compare our findings across the four categories, three particularly salient themes emerge: (a) Mothers who perceived science as fun projects or as a tool for maintaining the home held perspectives on science that were more personal, dynamic, and inquiry-based; (b) mothers who spent more time doing science with their children moved beyond a narrow vision of science more often than those who did not ("working with children"); and (c) certain topics and domains that were familiar to them, such as food, nutrition, and child care, facilitated the mothers in becoming border crossers. In other words, mothers also changed their perceptions of science based on context and need (border crossers). In what follows, we develop these crosscutting themes in more detail.

Personal, Dynamic, and Inquiry-Based Perspectives of Science

A comparison of the four categories of science perceptions suggests that mothers who perceived science as fun projects or as a tool for maintaining the home held perspectives on science that were more personal, dynamic, and inquiry-based than mothers who perceived science as schoolwork/knowledge or an untouchable domain. In other words, mothers who perceived science as fun projects or as a tool talked about science in ways connected to—and sometimes embedded within—their lives. Science was not a separate entity for the expert to pass on to the novice. Science was something that the mothers could initiate on their own, for reasons

of their own choosing. For mothers who perceived of science as an untouchable domain or as schoolwork/knowledge, this kind of personal initiation and inquiry was replaced by fear, prescription, and clear demarcations between those who know and can do science and those who can only receive science.

The distinction between mothers who viewed science as personal, dynamic, and inquiry-based and those who did not is important because it represents a major shift in perceptions of science. Viewing oneself as an active contributor within scientific circles, whether that be toward the construction of new and innovative scientific ideas or in applications of known ideas for personal use, suggests a level of intimacy with the subject of study (Harding, 1991). In feminist terms, it suggests that these mothers felt more in control of the science in their lives rather than controlled by the science in their lives. This shift in power dynamics is a crucial distinction in understanding how we might better work with parents to be proactive advocates in their own and their children's science education.

For us, this particular distinction between perceptions of science raises two questions. First, what is it about the kinds of experiences mothers have had with science that influenced their perceptions of science as more or less personal, dynamic, and inquiry-based? What kinds of experiences might we provide mothers who continue to feel controlled by, or at least separate from, science? Second, what can we learn from mothers who are able to articulate when and how such a shift might have occurred for them or their children? The next two crosscutting themes to emerge from our analysis (working with children and border crossing) begin the process of unpacking these questions.

Working With Children

Our comparison of mothers who perceived of science in more personal and dynamic ways and those who did not reveals that one potentially important influence is how much time the mothers spent doing science with their children. Our data suggest that mothers who described having spent significant amounts of time doing science with their children and provided concrete examples of doing science with their children more often described science in personal, dynamic, and inquiry-based ways.

For example, all mothers who participated in this study were asked how often they engaged in science with their children and what kinds of science activities they did with their children. All 15 mothers who perceived of science as fun projects or a tool for maintaining the home provided detailed and concrete examples of doing science with their children. However, of those mothers who perceived of science as schoolwork/knowledge and as an untouchable domain, only 7 of the 13 indicated spending time doing science with their children.

It seems to us that some of the mothers were unable to break through the barrier of the mystery of science unless they had experiences doing science with their children. It may be that many of the mothers in our study were introduced to science formally in school, through visits to health care professionals or through the media in ways that were authority driven (i.e., teacher, doctor, and text driven). Through doing projects, fun activities, or home-based chores with children, it may be that for the first time some of these mothers were able to wonder about science and the world around them without the worry of reading assignments, studying for tests, completing papers, or methodically recording experiments. After all, as we will discuss in the next section, some of the mothers' perceptions of science shifted depending on whether they were describing science abstractly (i.e., what is science) or whether they were describing experiences doing science with children (i.e., tell us about a time you remember doing science).

This finding regarding perceptions of science and mothers' science experiences with children raises two issues in particular. First, it is not clear whether mothers participated in science with their children because they felt more connected to science to begin with, or whether their interactions with their children helped to influence these mothers' perceptions of science in positive ways. This issue warrants further exploration. Second, we wondered whether the nature of the experiences with children matters. What about mothers who become involved in their child's science class? Could this kind of participation positively influence mothers' perceptions of science? What about school science extension activities for the home? Could this kind of participation positively influence mothers' perceptions of science? This issue, too, warrants further exploration.

Crossing Borders

The third crosscutting theme, crossing borders, is closely linked to the previous theme, working with children. At the beginning of our findings section, we noted that there were six mothers whose perceptions of science varied depending on the context of their talk about science. Three mothers whose ideas about science reflected science as school knowledge/work and one mother whose ideas reflected science as projects expressed ideas that could also reflect the perception that science is a tool for maintaining the home and family when the contexts of their talk related to food, health, and nutrition. In addition, two mothers whose ideas about science reflected science as school knowledge/work expressed ideas that could also reflected science as projects when the contexts of their talk related to food, health, and nutrition.

For example, many of the mothers who talked about science in strictly school terms began to talk about science and home-based knowledge when food-based contexts arose. Mothers told stories about children's health issues such as what to do about a child who does not like protein and as a result has to take iron pills, what kinds of healthy snacks they give their children, and how they teach their children good hygiene. As stated at the outset of this article, we intentionally asked the mothers what they thought about food and science: How did food and science relate? How can or should work with food be science? How might food be used in schools to help teach science? We asked these kinds of questions in part because we were in the process of developing a food-based science curriculum for elementary children and their teachers and caregivers. We also asked these questions because we had a hunch that context was important. We were curious to find out how such a familiar context as food influenced mothers' perceptions of science.

For the most part, the mothers' responses to these food-based questions reflected their general perceptions of science, but for a subgroup of mothers these contexts resulted in a major shift in their perceptions. The following quotations are from Rita, a woman whose perceptions about science we categorized as schoolwork/knowledge. She largely talked about science in apersonal and abstract terms. Science was a school subject to be tackled. She thought it was hard and did not like it. She was never smart enough to get what her teacher wanted her to learn. However, as these quotations suggest, like the other border crossers, when Rita began to tell stories about science in the context of food, health, and child rearing, her ideas about science were different. In the quotation that follows, Rita described growing plants. The interviewer had asked for the mothers' views and opinions about teaching science through food. The first mother described how it might be important to have the students learn about the stages of mold growth, how to grow plants without soil, and yeast and how bread rises. Rita also volunteered a response. Unlike the other mothers in this particular segment of the group interview, Rita deviated from

describing any prescription for what to teach or how to teach it, to tell a story of how she has come to know some science through food and her own daily activities:

I like avocado pears so I take the center of it and I put it in the dirt and it makes little leaves. If I find a dead leaf, flowers I murder, I'm not a green thumb as they call it, but someone gave me one little leaf from Barbados and that was over 10 years ago and I still have that plant. It was a piece of leaf that they brought back in some tissues. They must have pulled the root out in Barbados. I thought this thing was going to die. My mother was alive at the time and she planted it and showed me what to do. And now that plant is, like, this tall. My mother got something to put on it to enrich it. If one leaf dies, you clip it off, then another one comes in its place. I tell everyone to watch out, my mother is watching over it.

Later, she built on her ideas about planting and gardening:

I'd like to see [my grandchildren] grow a little garden with flowers and plants. . . . Let them see start out with a little seed, go out to the garden to nurture the plants and they can see how the greens grow, they can get a vegetable garden and a flower garden . . . we can get the soil from the shed!

Although it may be a bit farfetched to say that Rita's talk about gardening and her stories about either Barbados or her children suggested that she strongly perceived science to be a tool for maintaining the home, it is clear that this familiar context helped Rita to think about science more personally and more broadly than the majority of her other comments about science indicated.

Another example involves Marita. Marita, as described earlier, shared many ideas about science as fun projects. However, Marita's ideas, especially when they were connected to talk about familiar things reflected more of science as a tool. In describing how she might teach science in school if given the opportunity, she stated, "I have a mango plant in my house. I show my children how it grows and I teach them that we are what we eat." Like Rita, Marita's ideas here might not be quite the same as science as maintaining the home as we have described this particular category, but we see Marita as a border crosser because she clearly is stretching how she sees herself, her personal knowledge, and what she wants to teach; whereas when contexts were not so familiar (i.e., volcanoes) she relied on the knowledge of experts.

Of course, one is more likely to be comfortable talking about science in more familiar contexts than in less familiar contexts. Also, one would talk about science in personal ways when the subject is relatively personal. These are obvious points regarding our description of crossing borders and the mothers' talk about science in the context of food and nutrition. The significance of this finding, however, is the kinds of connections the mothers made among themselves, their experiences, and their perceptions of sciences. In fact, we use the phrase "border crossers" because we see these mothers as having found ways to move from more limiting (and indeed more alienating) to more empowering visions of science, especially as it relates to doing science with their children. This notion of border crossing among these women connects well with other research in science education which describes the multiple ways in which students (and in our case, mothers) move from traditionally defined scientific domains and descriptions to home-based and culturally based experiences (Jegade & Aikenhead, 1999). In particular, mothers who believed that they could not take science out of the classroom or that the science learned in science class did not apply to their everyday lives changed their perspectives when they talked about food, health, and child rearing. Some of the mothers even expressed "ah-ha's" when they

made the connection to their everyday lives. For example, when talking about food and science, one of the mothers explained an idea she had for planting a garden with the children and how this garden might be useful in teaching science through food. Several of the mothers responded to this idea enthusiastically. One mother in particular, who had previously spoken about science in only traditional school terms, used this opportunity to expand the food and garden idea: "Let [the children] see. Start out with a little seed, go out to the garden to nurture the plants and they can see how the greens grow. They can get a vegetable garden and a flower garden and that would be their project and have each group of children doing that. . . . I think that is a good plan. I would bring it to the PTA and we could go as a group to [the principal] and tell her exactly what we want 'cause there are a lot of good ideas but if you don't bring them as a group, they go down the drain." This mother, like the other border crossers, not only pushed her own thinking about science but also demonstrated a qualitatively higher level of comfort when she talked about science as a life experience and the importance of this kind of experience in school settings.

Thus, the mothers' perceptions of science were somewhat fluid depending on context and kinds of experiences. The mothers in our study who perceived science as fun projects or as a tool for maintaining the home held perspectives of science that were more personal, dynamic, and inquiry based. It was often mothers who held broader views of science who also described themselves as having spent significant amounts of time doing science with their children. Most interesting, however, was the subgroup of six mothers whose perceptions of science altered in significant ways when the context of their talk about science changed to the home-based and familiar topics of food, nutrition, and child care. All six of these mothers moved from a more limiting, nondynamic, and apersonal perspective of science to one that more fully embraced a dynamic, personal, and inquiry-based perspective on science.

Implications

The findings from our study with the mothers suggest that the mothers' perceptions of science in our study can be grouped into four categories: perceptions of science as (a) schoolwork/knowledge, (b) fun projects, (c) a tool for maintaining the home and family, and (d) an untouchable domain. A cross-comparison of these themes further reveals that mothers who perceived science as fun projects or as a tool for maintaining the home held perspectives on science that were more personal, dynamic, and inquiry based; mothers who spent more time doing science with their children moved beyond a narrow vision of science more often than those who did not; and some mothers became category crossers when they were asked to discuss science with topics and domains that were familiar to them, such as food, nutrition, and child care.

The implications for these findings are great. The descriptions provided by this sample of mothers and mother surrogates of poor urban elementary school children were rich and detailed and suggest several implications for ways for thinking about involving parents in science education initiatives through in-class activities, home-based extensions, or extramural workshops. There are three areas of implications regarding our findings.

Acknowledgment

Our observations suggest mothers' perceptions of science must be acknowledged by those in science education (teachers, curriculum developers, etc.) and used in ways that will support their own growth and development in science. For mothers who come to science education

programs with personal and dynamic views of science, these views need to be acknowledged and supported. For mothers who come to science education programs with less personal and dynamic views (i.e., science as schoolwork/knowledge or science as an untouchable domain), these views also need to be acknowledged and expanded in supportive ways for two important reasons. First, we believe that it is important to help push parents along in their views of science so that their views are more dynamic, personal, and inquiry based. Second, as we stated in the literature review, many parents already feel alienated from school and science. If we understand parents' starting points better, we may be more able to work toward more genuine, positive, collaborative relationships. In short, science education experiences should capitalize on and hone mothers' existing inquiry skills, reinforce the notion of science as process (as opposed to only a content to be learned), and reaffirm the connection between their own everyday experience and science as process.

Involvement

Our findings that the mothers in our study who spent more time doing science with their children more often held personal and dynamic perceptions of science suggest that any school-based initiative to promote parental involvement in science education also ought to involve children directly. The mothers seemed eager to help their children understand how the natural world around them works and were indeed quite competent in transmitting both content and process of everyday science to their children. Enhancing science and nutrition literacy among these parents should thus involve helping them value what they are already doing with their children and in making the connections between these everyday activities and what children learn in school science.

Context

Finally, our findings suggest that some of the mothers' perceptions of science were influenced by context. Some mothers were border crossers in terms of their perceptions of science when describing food, nutrition, and child care activities. These activities are daily experiences for the mothers, and it makes sense that framing science in these terms provided the space for talk about science to become more personal and dynamic. Given our own interest in generating curricula that links parents, children, and teachers together in inquiry-based science, one implication of this finding is that food and nutrition may be a strong domain through which connections can be made between the everyday science practices of mothers and children and school science. Using these familiar contexts, because they seem to lend themselves to mothers feeling more involved in science may also help to enhance mothers' science and nutritional literacies and skills, their confidence in their ability to help their children do science, and their interest in participation with teachers in school science education.

The U.S. Department of Education (1997) stated that "We know that when educators, families, and communities work together, schools get better. As a result, students get the high quality education they need to lead more productive lives. Yet, various barriers in school, home, and community often prevent strong partnerships from developing" (p. 1). We believe that one barrier that would hinder collaborations between science educators and families forward is the differences in understandings about and perceptions of science. If we can better articulate what these differences are and how they might be overcome, we may help to generate positive sustained school–family relationships in science education.

Notes

¹Not all mothers attended all 10 sessions. However, for this article we draw largely from the first 2-h meeting where the mothers talked about science and their experiences in science.

²These numbers of mothers in each category tally to a number greater than 24 (the number of mothers in our study). This is because some of these mothers held perceptions from more than one category (see Discussion subsection, Border Crossers).

³For a description of the three mothers who did not return to school connections, please see Border Crossers in the Discussion section.

⁴All names used in this article, with the exception of the authors, are pseudonyms used to protect the identities of the research participants.

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