PHYLLIS KATZ

12. IDENTITY DEVELOPMENT OF MOTHERS AS AFTERSCHOOL SCIENCE TEACHERS

INTRODUCTION

Research on teacher identity development in science education has concentrated on the identity development of classroom teachers (e.g., Avraamidou, 2014; Beijaard, McKinnon, & Lamberts, 2014; Flores & Day, 2006; Luehmann, 2007; Meijer & Verloop, 2004; Volkmann & Anderson, 1998; Watson, 2009). Among these authors are researchers who have reported on how informal science education venues have assisted in classroom teacher identity development (Avraamidou, 2014; Luehmann, 2007; McKinnon & Lamberts, 2014). In this chapter, I explore identity development within an informal setting-an afterschool science enrichment program. Seeing oneself as a "certain kind of person" is a key component of identity and one's capacity to participate in a specified community (Gee, 2001; Wenger, 1998). The teachers, who were called "Adult Leaders", considered their primary identities to be "mothers." I was interested in the contribution of the context to the identity changes they described and were observed to be undergoing. I was also interested in the interaction between their afterschool science teacher identity development and its influence on their parenting identity. Science is a basic human endeavor. As such, parents, who pass on attitudes of competency or interest in science are critical to the participation of the next generation. Science learning can be defined broadly as seeking out patterns for how the world works (Dewey, 1916; Kneller, 1978; National Commission on Excellence in Education, 1983; National Research Council, 2014; Rutherford & Ahlgren, 1990). In this broad sense, we all teach science. We teach as we model curiosity and everyday research within our families. We teach as we share resources from the practices in our lives for health and safety. We teach as we advocate for good school science. As Rogoff (1990) stated, "Whatever practices children observe their parents carrying out and whatever goals children see their parents striving for have special significance for children" (p. 88). Most parents are not professional science teachers who have followed the studies of best practices in science education. This chapter relates how a sample of women whose core identities are as mothers elect to become teachers in an afterschool science program and begin to grow a new identity which then influences their families. There has been evidence for decades that tells us that learning opportunities for parents, but especially, mothers, contribute to the socio-cultural environment of the family in ways that support the

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future of their families (Bempechat, 1990; Halgunseth & Petersen; 2009; Rogoff, 1990; United Nations Population Fund, 2005). In this chapter, I present additional evidence within a particular science education setting that the teaching and learning that occurs is a case of building capacity and confidence through participation and identity development. The identity development within the afterschool science program is then in dynamic interaction with other identities—the primary one being as a mother.

There is little research on mothers who teach in an informal science context. There has been writing and research that have asserted the importance of the home environment and how it can be predictive of interest and school success (Bloom, 1982; Crowley & Galco, 2001; Gottfried et al., 1998; Tamir, 1991; Tamis-LeMonda & Rodriquez, 2008). Most often it is women who spend more time than men interacting with their children's early activities. And yet mothers of young children, as well as elementary school teachers (most often women) reflect the cultural environment that has frequently yielded reticence in their approach to science and mathematics (AAUW, 2010; Avery & Meyer, 2012; Jung & Tonso, 2006). We have seen that as mothers' education increases, the standard of living of the family can increase, especially with math/science related fields (AAUW, 2010; Skolnick et al., 1982). The benefits of science in daily decision making and in the job market are notable. Since many women who spend much of their time with children still voice a lack of confidence in science, this may well replicate itself in their interactions with the next generation. Professional classroom teachers have the support of their educational systems for their science education development, but the family is not part of that identity developing community.

Mothering does not come with a manual. When preparing for career work, many professions include a practicum that provides experience and a means of becoming a community member. Practice has long been recognized as an effective way of learning. Medical students must have an internship before they are certified as physicians. Many law students intern in law firms before they are admitted to the bar. Tradespeople must be apprentices before they can be deemed masters of plumbing, carpentry or electricity. Classroom teacher candidates do student-teaching prior to licensing as classroom teachers. In each profession, would-be practitioners learn from those more experienced in situ. Although mothers are engaged in everyday science learning and teaching while they cook, clean, select and play with toys and more, there is no obvious internship for this work. The opportunity to teach in an afterschool science program may have provided the mothers in this study with just such an apprenticeship. The data provide evidence that they gained competence and confidence about science and its teaching that they had not previously had to share with their families and others. This is a study of what happened to mothers willing to participate in the research and likely is biased by their willingness to be a part of it. Unsatisfied mothers would not be expected to spend their time in research in an unhappy situation. The findings therefore, represent a "best case" scenario of the potential of such programs.

AFTERSCHOOL LEARNING OPPORTUNITY

For more than two decades afterschool learning time has been studied for its potential to assist and protect students when their parents are still at work. A Matter of Time (Carnegie Corporation, 1992) describes the U.S. socio-cultural environment and how afterschool programming makes a difference, especially for at-risk youth. A major report, Expanding Minds and Opportunities, contains sixty-six chapters written by prominent practitioners and policy makers detailing the benefits of afterschool programming (Peterson, 2013). Of these, six are clustered in a section on engaging families. None speaks of the identity changes that parents undergo by participating as teachers. The Girl Scouts of America did survey research in 1997, which included outcomes for troop leaders. Many of their badge programs include science components in such areas as cooking, environment and outdoor skill building. The data in the report do not disaggregate the many experiences that scouting covers, but the report provides findings relevant to mothers as leaders. Over 90% of those surveyed agreed that they experienced things they otherwise would not get to encounter. Over 80% agreed that they developed skills that they would not otherwise have developed. Over 70% agreed that their self-confidence had grown (Hwalek et al., 1997). In parallel, over the last thirty years the process of science teaching and learning outside of school has been garnering more attention as researchers study the components of what fosters both interest and accomplishment in science (Bell et al., 2009; National Research Council, 2014). One unexplored area is how afterschool science teachers, those who approach science teaching not as a career, but as an enrichment activity, come to see themselves as teachers of science. The research in this chapter focuses on the identity development of afterschool science teachers as both teachers and learners.

Afterschool science teachers are usually not invested in career positions in science teaching when they choose to lead groups of students in out-of-school activities once a week. They are recruited to science teaching from a variety of other communities and identities. The women in this study presented themselves as the mothers of students for whom they wanted a science enrichment program available. The research used a purposefully diverse sample to explore commonalities among women from varied ethnic identities. I was interested in how the science teaching identity development of the mothers might also influence their identities as mothers across these differences.

THE AFTERSCHOOL SCIENCE ENRICHMENT PROGRAM

This afterschool science enrichment program began in 1980. It was structured to make science enrichment easily available to children from pre-k through elementary school years. It took place in schools for the most part, but also in churches, camps, recreation centers and other convenient gathering places for afterschool programs. The program ran for three seasonal sessions of eight weeks each during the school

year (fall, winter, spring) for an hour a week, like comparable music, dance or sports classes. The groups were small (9–11 children) and clustered by grades (pre-K, K-1, 2–3, 4–6) reflecting the need to plan activities that could assume physical development and general experience upon which to build. There were also three two-week daily sessions during the summer vacation period. There were three broad yearly themes: Structure and Change, Patterns, and Energy. Sessions included programs like "The Toymaker" exploring simple machines for 2nd and 3rd graders, "Layers" for K-1 children exploring a range of observations and activities from clouds, to life on a log; "Good vibrations" for 4–6th grade children including pendulums, music and kites. Enthusiastic children could continue for the duration of the program over their elementary school years because they would advance in grade level as the themes rotated and thus not repeat activities. Inquiry teaching/learning strategies were meant to provide scaffolded learning (Berk & Winsler, 1995). Inquiries were guided with questions: "What do you already know about…? This was followed by "What if" we tried an experiment or a model? Children were encouraged to play with alternatives or to build something that could be tested, and investigations were concluded with "So What?" questions about the relevancy to the children's experience. Materials were provided for each child to use and take home with communications to parents.

THEORETICAL PERSPECTIVES

I like to begin my investigations with who we are as humans, trying to gain insights into what needs are being met by our actions. Sociobiology theory describes the natural selection for social behaviors that will maximize survival and continuity (Wilson, 1975). A key theory within this overall explanation of social organisms is that of parental investment. This describes how parents will engage in behaviors that will provide the greatest opportunity for their children's survival and success (Trivers, 1974). The concept of "investment" highlights the amount of time, resources and type of attention parents may provide. The term "investment" also suggests that the limits of parental resources affect a child. But "resources" is an encompassing term that can mean much more than money or goods. It plays a part in the interpretation of my findings. Parental investment is often an assumption. For example, one section of the recent afterschool report Expanding Minds and Opportunities (2013), states among its action steps for parent involvement:

> Recognize that all parents, regardless of income, education level, or cultural background, want to be involved in their children's education and want their children to do well in school. (Osterhaus, 2013, p. 335)

Identity development theory flows from sociobiological theory. Social animals, including humans, are by definition those that belong to and interact in groups. They are recognized as members. Participants have roles within the groups that support membership and themselves. Wenger describes identity development as just such a necessary process for people, using the term "investment" as well.

> By identification, I mean the process through which modes of belonging become constitutive of our identities by creating bonds or distinction in which we become invested. Because, it represents an investment of the self, identification generates the social energy that sustains both our identities and our communities in their mutual constitution (Wenger, 1998, pp. 191–192).

The focus on identity development in teaching has been a powerful explanatory theory because it is consistent with who we are as social beings. The afterschool science program teaching was a small part of the lives of these women who held other identities within other communities as well. They were members of religious groups. They belonged to book clubs. They were on sports teams and other "member" groups. To make clear to both the out-of-school and surrounding communities that these teachers were not to be confused with highly prepared and invested career teachers, we used the title "Adult Leader." The afterschool science teaching practices in this case were based on science philosophy and education theories of hand/mind processes succinctly described by Jacob Bronowski:

> I have described the hand when it uses a tool as an instrument of discovery; We see this every time a child learns to couple hand and tool together—to lace its shoes, to thread a needle, to fly a kite or to play a penny whistle. With the practical action there goes another, namely finding pleasure in the action for its own sake—in the skill that one perfects, and perfects by being pleased with it. This at bottom is responsible for every work of art, and science too: our poetic delight in what human beings do because they can do it. The most exciting thing about that is that the poetic use in the end has the truly profound results. Even in prehistory man already made tools that have an edge finer than they need have. The finer edge in its turn gave the tool a finer use, a practical refinement and extension to processes for which the tool had not been designed. (Bronowski, 1973, p. 116)

The positive outcomes of interacting with materials have been confirmed many times (Sadi & Cakiroglu, 2011). When we argue for the importance of out-of-school learning, we acknowledge that learning is continual, complex and cumulative (Dierking et al., 2003; Tal & Dierking, 2013). There are certainly many ways to study science, such as direct instruction, but in this informal science afterschool program children were attracted by taking part with and taking home materials.

From this approach to hands-on activities grew the materials kits that supported the out-of-school science teachers. The teachers could prepare conveniently by doing their own activities and experiments from their boxes. The enrolled children brought home their efforts for display, discussion, or re-use. The evidence to be discussed below told us that the Adult Leaders's children often engaged in the program preparation with their mothers. The teaching process was guided inquiry. In the National Science Education Standards scientific inquiry was described as "the diverse ways in which scientists study the natural world and propose explanations" (National Research

Council, 1996). The capability to do scientific inquiry is a continued goal in the U.S. Framework for K-12 Science Education (NRC, 2012). The constraints of preparing a program for national distribution limit the wider possibilities of self-determined inquiry, but the afterschool science program design did allow for individual and group inquiry decisions based on interest, prior knowledge, and safety within these limits.

FINDINGS

Data for this study include drawings to elicit mental models of scientists. Mental modeling theory suggests that we hold representations in our minds to understand our experience (Norman, 1984). As we live and learn we may alter these models. We used the Draw-A-Scientist procedure for additional data to follow changes in the mothers' mental models of who does science, in what settings, and with what materials/investigations. In prior research, drawings have been used in mental models research (Vosniadou & Brewer, 1992). In previous research, we have used drawings to follow the changes in the mental models of pre-service teachers as they progress through their teacher preparations programs and into the field (Katz et al., 2013; Katz et al., 2010). Drawings have been used to consider what is revealed about gender bias, appearance, and activity when people are asked to put their thoughts down visually (Kahle, 1989; Tippins, 1995). I continue to use drawings as a data source to complement other methods of data collection.

What follows are samples of the evidence of this diverse group of women and their journeys in becoming members of a specific afterschool science enrichment program teaching community. In addition to interviews, observation notes, and journal entries, these women were asked to draw their images of scientists. The interviews took place at the beginning and end of each of the two sessions in the study, over a period of approximately six months. The purpose of the interviews was to converse about how the research participants thought about themselves, science and their parenting as they taught and learned in the afterschool program. These interviews lasted about an hour each time and the drawings were done during part of this time. At the first interview, the women were asked about their own science education experiences and their previous teaching experience. At all interviews, the women were asked to talk about the science activities that they found themselves doing in their daily lives. Below are some sample interview questions:

- How do you feel about your ability to do science? To teach science?
- What kinds of science activities could you do with a piece of paper?
- Do you choose to share any of your afterschool science enrichment activities with your family? Examples?
- Do you use any of the teaching techniques (wait time, question formation, simple materials) with your family? Examples?

The drawings provided additional insights into the changing mental models these women held as they came to see themselves as competent science participants and

teachers in the setting. It may also be that out-of-school settings provide resources in science teacher identity development support that is not available in formal educational settings (Avraamidou, 2014; Luehmann, 2007; McKinnon & Lamberts, 2014). Although these researchers were considering classroom teacher identity development and the potential contribution of out-of-school science educators and their venues to classroom teaching, here I suggest that the same out-of-school settings may provide similar benefits to those who are not career teachers, but whose influence within the family setting can accumulate to a change of cultural attitude toward science and science education.

THE PROCESS OF AFTERSCHOOL SCIENCE TEACHING IDENTITY BUILDING

The Participants

There were twelve focal women who agreed to participate in the study presented in this chapter. Three each were located in four communities in the U.S. that offered the afterschool science program: mid-Atlantic coast, north central, southwest, and west coast. The four sites used the same instruments on the same schedule. The women were interviewed and observed. They kept prompted journals and did drawings. Brief descriptive information about the range of study participants is in Table 12.1:

Table 12.1. Study participants varied backgrounds

Name	*Education*	*Ethnic background*	*Prior teaching?*
Cathy	Master's in environmental science	Caucasian	No
Jane	Master's in music	Caucasian	Private piano instructor
Hillary	Bachelor's in art	African American	Instructional assistant
Kay	Almost a B.A. in Business	Caucasian	No
Pam	B.S. Chemistry	Caucasian	Religious school
Janet	B.A. Math and History	Caucasian	Yes, not science
LeShawn	B.A. Education	African American	Elementary school teacher
Lilly	A.A. Admin Assistance	African American	No
Beverly	A.A. Restaurant management	Caucasian	Vocational education
Pat	One year college	Multi-ethnic	No
Yolanda	A.A. in social science	African American	No
Roxanne	High school	Caucasian	No (clerk in elementary school)

These women did not begin their participation as afterschool science teachers by including "science teacher" among their identities. They had a wide range of prior experience, but not as afterschool science teachers. Most began their out-of-school teaching journeys enthusiastically, anticipating a pleasure in learning:

> I will be learning and I will be experiencing and it will be fun for me to do, too. (Hillary, interview)

> I just want to say I want to learn more science and by being a woman myself and a minority, I want to learn a little bit more, and I think I will. I know I will, by working with these kids. (LeShawn, interview)

> I'm looking forward to being able to do a good job with the students, learn something, and hopefully get a chance to do something else. (Lilly, interview)

As they led their groups, there was evidence that they did come to see themselves as non-professional science teachers in an afterschool community of practice where teaching meant learning to them.

> I feel that as an informal science class leader I am learning with my students and experimenting with causes and effects. There are things I don't know and by listening and doing…I ask questions. (Hillary, journal)

> I was talking about the bridges. I took chemistry and stuff like that, but I didn't take any engineering. I was not into that kind of science, and it fascinated me that just putting a couple of girders on a bridge really made it a lot sturdier and we all trusted it more to walk over it. And the codes…I'd never heard of a rebus; I'd never heard of a scytale. I've learned along with the kids, all these codes. I think that as we age sometimes we think, "Oh, we know it all." But if you teach your kids then you're always learning- you're always learning. (Pam, interview)

It became apparent that the women in this study developed an interest in afterschool science teaching because they wanted to aid their own children's science education both directly in teaching and through their own learning, consistent with the parental investment theory of sociobiology. I found that with the willingness of these mothers to invest in preparation and teaching time came the changes that they had to undergo to see themselves as afterschool science teachers and to be seen by others as afterschool science teachers. As they spoke and wrote about their teaching experiences, they were specific about how they shared their science learning with their children, who became participants in the home as a result of their mothers' teaching:

> I'm glad I'm a teacher- a leader-because I'm going to see ways to help my children and help them to continue with those trips we make to museums and centers and that Explore It center that came to the school. I'd like to go there.

> I like to do that. I'm seeing ways I can bring those to more than my children's eyes, so they can learn and be more interested in science. (Pat, interview)
>
> I do always make an example of whatever item the science program of that day has me using, and I test it so I'm sure I know what it's going to sound like, what it looks like, and a lot of times, I will go to my family and say, "Oh, you really need to see this," or "Isn't this neat?" and that has been a lot of fun and I feel that if I continue to participate in {the afterschool science program] that the whole family keeps gaining from each one of those lessons, because they have this little mini exposure to whatever the program includes that particular week. (Cathy, interview)
>
> I shared the whole class with my son, who is seven years old. He enjoyed it and so did I. He thought it was strange that I asked him so many questions. (Jane, journal)
>
> I always share with them, because every time I come home, my kids are looking in my bag, like I've got a goody bag, and they say, "What do you have left over?" (laughs) And I say, "Well, let me see. How did you do today?" And so that's how we share. Every Wednesday they say, "Did you have science program today? What do you have left over?" And it's really a treat for my kids to see what I have left over, and they say, "What do I do with it?" and I say, "You go and you test this. You go see what you can find." My son usually finds something that he can do with it…(Hillary, interview)

INTENTIONAL IDENTITY DEVELOPMENT STRATEGIES

The entire process of building a staff of afterschool science teachers was one of intentionally developing a community and afterschool science teacher identities within it. As a first step, to be included in the community, these mothers had to choose it. It was not uncommon for women who answered the advertisement for afterschool teachers to dismiss themselves when we answered the telephone as an afterschool science enrichment program. If they didn't quickly hang up, they would be asked if they used a lever, or wheel and axle in washing that morning. The response would acknowledge that they then had some experience with simple machines. A conversation could continue about the choice of facial soap and again, the mothers would hear that they were using their information about drying agents and lubricants in a simple form of home chemistry. They were encouraged to see themselves as everyday science participants. This beginning of a change in perspective started with these early conversations as a welcome to this particular out-of-school science teaching community. Those who took this first step still had to be screened, of course for security, legality to work, education, and experience with children. Once accepted, they were welcomed as novices in the preparation session. Mothers were available in the evenings. The program provided a light meal to assist

in alleviating meal time as less of a roadblock. Food is a welcome procedure in many cultures.

Then, as part of a group of new Adult Leaders, the mothers underwent an induction at "New Leader Orientation." This was followed by an initiation in which they met with new and experienced peers in the afterschool science teaching community to practice activities and inquiry and management techniques for the upcoming session. The training for these Adult Leaders centered around confidence building in inquiry teaching. Here was a time among peers to preview activities and ask questions about techniques and concerns. There was also practice in their adult resistance to saying, "I don't know." The program design was meant to model interactions with children where the adults are not repositories of all knowing. Adult Leaders were encouraged to nurture children to explain their findings, share information, see science as pleasurable and look at unexpected outcomes as opportunities, not failures. The professional afterschool science educators modeled enthusiasm.

Once in the field, the Adult Leaders were offered support by phone or email. After a few weeks, the Adult Leaders were observed and validated by an observer's discussion with them. The Adult Leaders received session completion certificates. Those who were observed to be especially successful with the children's groups and who were enthusiastic were invited to participate in training others. Our findings suggest that these processes contributed to "afterschool science teacher" identity or to withdrawal (or occasionally removal) from the community. The figure below summarizes afterschool science teacher identity development as structured by the afterschool science program's design (Figure 12.1). The figure describes "mother" as the primary identity, the processes built into the afterschool science program for

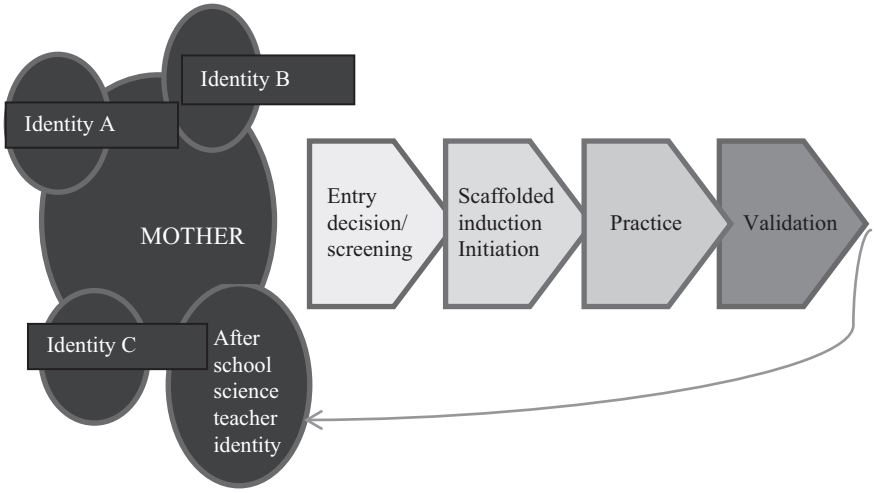


Figure 12.1. Identity development design of the afterschool science enrichment program

Adult Leader development which then lead to the inclusion of "afterschool science teacher" identity, among other identities held by those in this study. Simultaneous identities could well include participation in sports groups, reading groups, or church activities, among others. Those Adult Leaders who made the choice to withdraw or who were not invited to continue will be discussed briefly later, as this chapter is focused around those who succeeded for themselves and how their identities as afterschool science teachers interacted with their identities as mothers.

ANALYTICAL FRAMEWORK

Since the setting of this research was in informal science education, I considered what distinguishes out-of school learning from that in compulsory education. I focused on the affective qualities of the experience as units of analysis because they might help explain the attraction and outcomes. These categories outlined by Simpson et al. (1994) compare four affective terms in Table 12.2.

Table 12.2. Description of affective qualities

Term	*Typical object*	*Major components*
Attitudes	Things, people, places	Contains affect, cognition and behavior
Values	Abstract ideas such as love, democracy, freedom	More emphasis on affect and cognition and less on immediate behavior
Beliefs	The general acceptance or rejection of basic ideas	More emphasis on cognitive acceptance or rejection
Motivation	Focused more on the desire to act or not act	More emphasis on the behavior component

Data were coded according to the criteria shown in Table 12.3. The responses were used to consider this evidence in terms of the static or dynamic interactions in identity development as the women continued to lead afterschool science classes.

BEYOND WORDS: DRAWINGS

The women in this study provided verbal evidence that their own participation in science teaching led them to share their experience with their children. The enthusiasm and new skills that they had learned in the afterschool science teacher initiation phase and practice in the program were expressed in the repetition of program activities at home and the use of open-ended questions and wait-time for responses at home. As the women became Adult Leaders in this program, I was interested in how their mental models of who does science might change. To investigate this aspect of

Table 12.3. Coding criteria for journal and interview data

Motivations	*Attitudes*	*Values*	*Beliefs*
Self: Causal statements about HOSO participation for self gain such as learning teaching techniques or group management.	*Teach/learn:* Statements of pleasure or anticipation, or displeasure in the teaching/learning process.	*Education*: Statements about the importance of the match between activities and learning goals.	*Self capacity to learn:* Generalized statements about the self as learner.
Own children: Mention of use of HOSO materials with own children as incentive.	*Setting:* Statements about the specific HOSO environment (small groups, specific activities, hands-on).	*My role in teaching/ learning:* Statements about the speaker's/ writer's role as an agent in the process as an important characteristic of the interaction.	*Children as learners:* Statements about children that consider their capacity to learn.
Others' children: Statements about participation in order to share knowledge.	*Science activity:* Statements about exploration, reading, discussion, related directly to science.	*Science Education:* Statements specific to the importance of science process or knowledge, compared to a general learning statement.	*Science as a way of knowing:* Statements that speak to beliefs about science for its methods and outcomes.

identity—that is, do they see people like themselves engaged in science—we asked them to draw a scientist. These drawings were done as part of the interview protocols at the start and finish of each of the two sessions during the research.

The use of drawings to research internal images of scientists was first used by David Chambers (1983). His test, the DAST (Draw-A-Scientist-Test) evolved from F.L. Goodenough's Draw A Man test (1926). White and Gunstone advocated for the use of drawings as data as they provided evidence that those who drew were expressing their ideas visually and might reveal unforeseen information that had not come out in verbal data (1992). As a gauge of the images of a scientist, the DAST has shown that many people hold a stereotype of a white, male scientist, sometimes eccentric, in a laboratory setting (Chambers, 1983; Schibeci & Sorensen, 1983; Flick, 1990). The criteria for scoring the DAST have varied from user to user, depending on the information of interest. Finson, Beaver and Cramond created the Draw-A-Scientist Test Checklist in 1995. Matkins and her working group on the Integrated Physical Science for Elementary Teachers (IPSET) project developed eleven indicators looking into affect, activity, inquiry and safety (1996).

Farland–Smith reported on a modified rubric in 2013. The school-based criteria were more detailed and appropriate to school-based learning programs. But there was precedent for customizing scoring criteria to a program, so I considered our own setting. I wanted to gain insights into the representations of gender, place, affective expression and what science activities included in our program would be present. I coded for the presence or absence of the categories in Table 12.4 after reaching consensus on the traits represented with colleagues in the program. These results were compared with the other data as described above.

Table 12.4. Coding of drawing images

Gender	*Setting*	*Affective expression*	*Science activity*
Female	None	Happy	Observing
Male	Laboratory/Field	Unhappy	Testing/Measuring
Not clear	Classroom	Neutral	Recording
	Informal (home, museum, garden...)	Cannot infer	Discussing
		Eccentric	Tool Use
	Solitary		Teaching
	Group		Creating

I was interested in the gender of the scientists these women drew. Seven of the twelve women drew only men at the beginning of the study. Kay drew both a man and a woman and four drew only women. By the end of the two afterschool sessions, the eight women who did drawings included women. Two of the eight included both male and female sketches. Cathy had drawn only a man on three previous drawings. This is what she said as she drew a woman doing science:

> Well yes, particularly because I know that when you first asked me to draw a scientist and I drew one and I knew the question was coming, "Is it a man or a woman?" Although I was self-consciously saying, "It's a man!," the truth is, it's a man...And so this afterschool program has kind of challenged me on that. Why is that? And isn't that interesting? Especially since in some ways I have felt very comfortable in science and all that, but the typical scientist I saw as a man. So that's challenged me to look at that and broaden. (Cathy, interview)

Hillary started her drawings with a woman in a laboratory setting with test tubes. She talked as she drew about what the woman was doing and how the parts of her drawing fit her scenario:

> I'm drawing a scientist with a lab coat. And now I'm drawing her. It's a lady scientist and she's got her back turned towards us and that's because she's fast at work. She has a test tube in her hand. Here's a table in front of her, and I'm drawing something that she would have her beaker in or that she can put extra tubes or something in. (Hillary, interview)

All but two of the twelve women depicted their scientists in a laboratory or field-work setting when they did their first drawings. By the end of the first afterschool session, about three months later, only two scientists were set in laboratory or field work. The lab/field increased to three for the third series of drawings and went back to two for the last group. Most illustrations then, were in other settings by the end of the study, suggesting that the women broadened their beliefs about where science was done. All of the women illustrated scientists working by themselves on their first drawings. Three of the women made a point in their first drawings of describing scientists as eccentric or different. Each of the three (Yolanda, Kay, and Lilly) made reference to the fact that they visualized males only. There were more male images where the expression was coded as "can't tell" or "neutral" than female images, which appeared to be "happy" or "neutral." Perhaps it is here that the women injected their own experiences and emotions about science as they were experiencing it. Their comments suggest this:

> We had a lot of fun with our middens and a story for each. I would also use a 1 lb. deli container for a variation of my midden... I felt like an archaeologist. (Beverly, journal)

> If you don't really get into it [science], you don't know a lot—just what's been told to you or what you see or what you use, even in the home. But just by doing that testing of different papers—that was interesting to me—I found that each time I do it, I get a little bit better at that. I really like that unit. And, you know, when you're doing little things around the house, you start looking at things, like how the sun is coming through the window. (LaShawn, interview)

The stereotypic "mad scientist" quality did not appear again in any of the later images. I interpreted this as meaning that these women developed alternative images of scientists to express as their afterschool science enrichment program experience continued.

In terms of science processes, testing and measuring, observing and using tools were all depicted as science activities from the start. However, no pictures illustrated discussions in the first drawings and some later pictures clearly did. Only Pat illustrated teaching as a science activity in her first drawing and continued to do so in each of her drawings. Yolanda, Janet and Pam illustrated teaching activities in the second set of drawings, five women did so in the third set and five in the last set.

Two women also illustrated "creating" as part of a scientist's work on their first drawings. "Creating" appeared in two illustrations on the second set, dropped down to none on the third set and was present in three of the last drawings. This was particularly interesting to me since so much of the science program includes construction and manipulation of materials. It might be that, as Cathy noted in her first comments, the creative part of science comes to mind much later than the tasks usually identified with scientific methods. She talked about her own comfort level:

> I really liked it when the material gave me the sense that I was teaching the scientific method. Whether it was data collection—I mean we didn't go through the whole thing, but just a piece of it, because the kids are so young. You aren't going to go through every form of hypothesis and all the way through testing and conclusion. But if we were doing something that was data collection, I would call it data collection, and then I could talk about "Scientists do this," in many different ways. In this last topic that I'm dealing with in the program, it was the shakers, where you made these little shakers, and some of the shakers had beans in them, some had paper clips, and some had cotton. And so they had to count, having gotten a random assortment of shakers, how many of each kind they had. And I really enjoyed that, and you were there again the day we did the testing again, the dropping of the two papers and so to me, that's what I like about science, when I feel like I'm talking to them about the reasoning part of it, the scientific method part. (Cathy, interview)

I would suggest that the afterschool program mothers, focused on following activity guides, do not interpret the activities as creative. I compared the women among the four research sites. I could discern no pattern apparent by site, lending additional credence to commonalities and the lack of researcher influence. Jane was uncomfortable with drawing. After an attempt at her first interview, she declined to try further, but she talked about what she could envision as a scientist. Gender was not an issue for her. At her last interview, she considered a female. She struggled to express that her image of a scientist was not tied to a laboratory or even a professional:

> I guess the first thing they [scientists] do is ask questions. And they're not terribly interested in knowing if they can get all the answers right away, but they like to ask questions certainly. And archaeologists just love asking questions. They're caught up on what kind of questions to ask, because if you don't, if you get caught in that whole mire, then you'll be closed to the ones you didn't ask. It goes on and on. So actually that's a big thing all by itself, isn't it? Just knowing, is not knowing what questions to ask, but what questions do we ask and that comes from culture. Boy, that's another whole can of worms. (Jane, interview)

> I guess I would think a scientist could be just about anyone, but I really can't draw even just anyone to make it look like anyone. But it could be, gosh, an archeologist, and you know what they look like....The common man. Do you really want me to draw it? It's going to look horrible. (Jane, Interview) It just could be a person. Could be female. And a scientist doesn't have to have three degrees anymore to be a scientist, to think scientifically. I think we tend to think of scientists as being these intellectuals and of course many times they are, but it doesn't prohibit other people from exploring things so that they can learn it on whatever level they're on. It doesn't have to become a doctoral

thesis to be science. So it could be a female, and I don't mean it that way, I just mean that it's an open field. (Jane, interview)

A first and final drawing for each mother is included in Figure 12.2. The changes in the drawings show a trend toward a broadening of what it is to do science, where and how it can be done and who does it. Since the women in the study were asked to draw these images four times (at the beginning and end of each of the afterschool science sessions in which the study was conducted), they were put in a position to consider what might be different from their previous image. In this way, the process of participating in the research in this drawing task motivated them to consider their more stereotypical initial images in terms of their own participation and identity development.

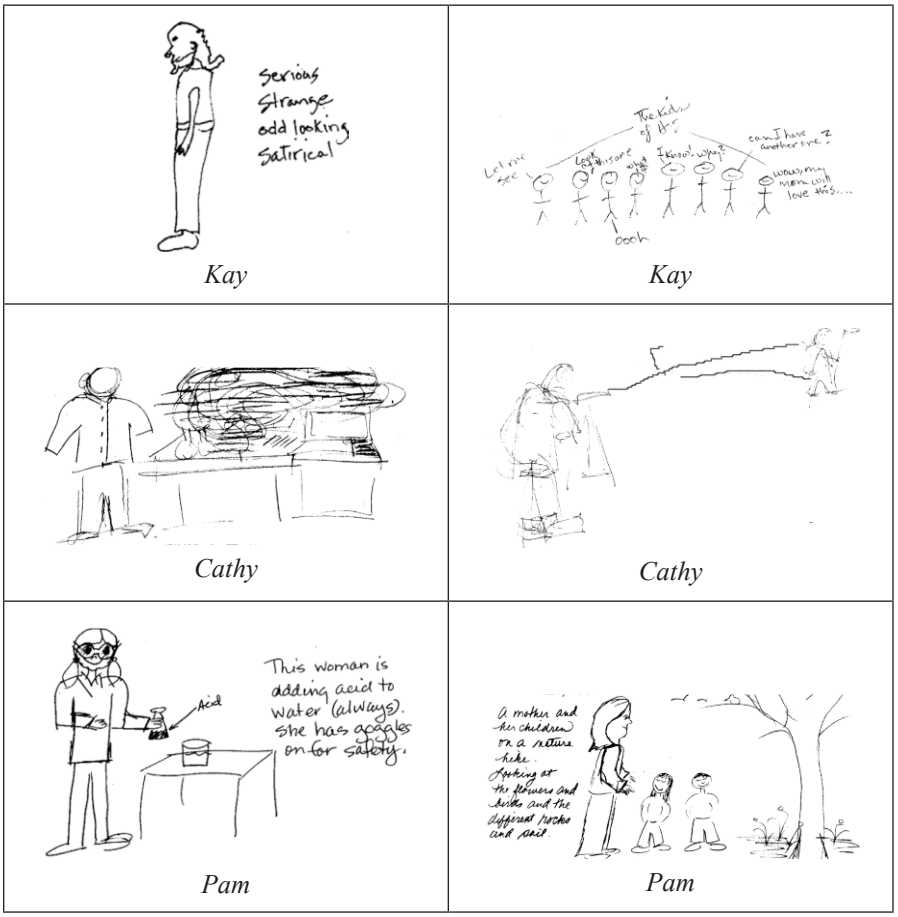
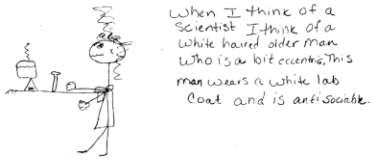
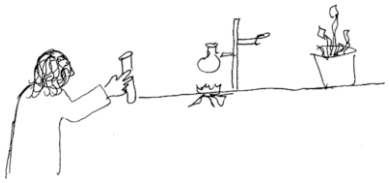


Figure 12.2. First (left) and last (right) "Draw a scientist"



Yolanda

Yolanda

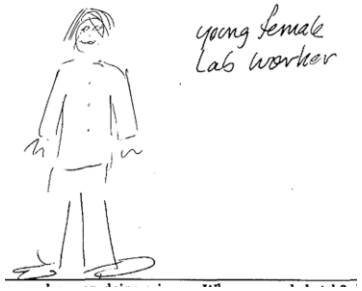


Hillary

Hillary

Lilly

Lilly



Jane

Refused

Figure 12.2. (Continued)

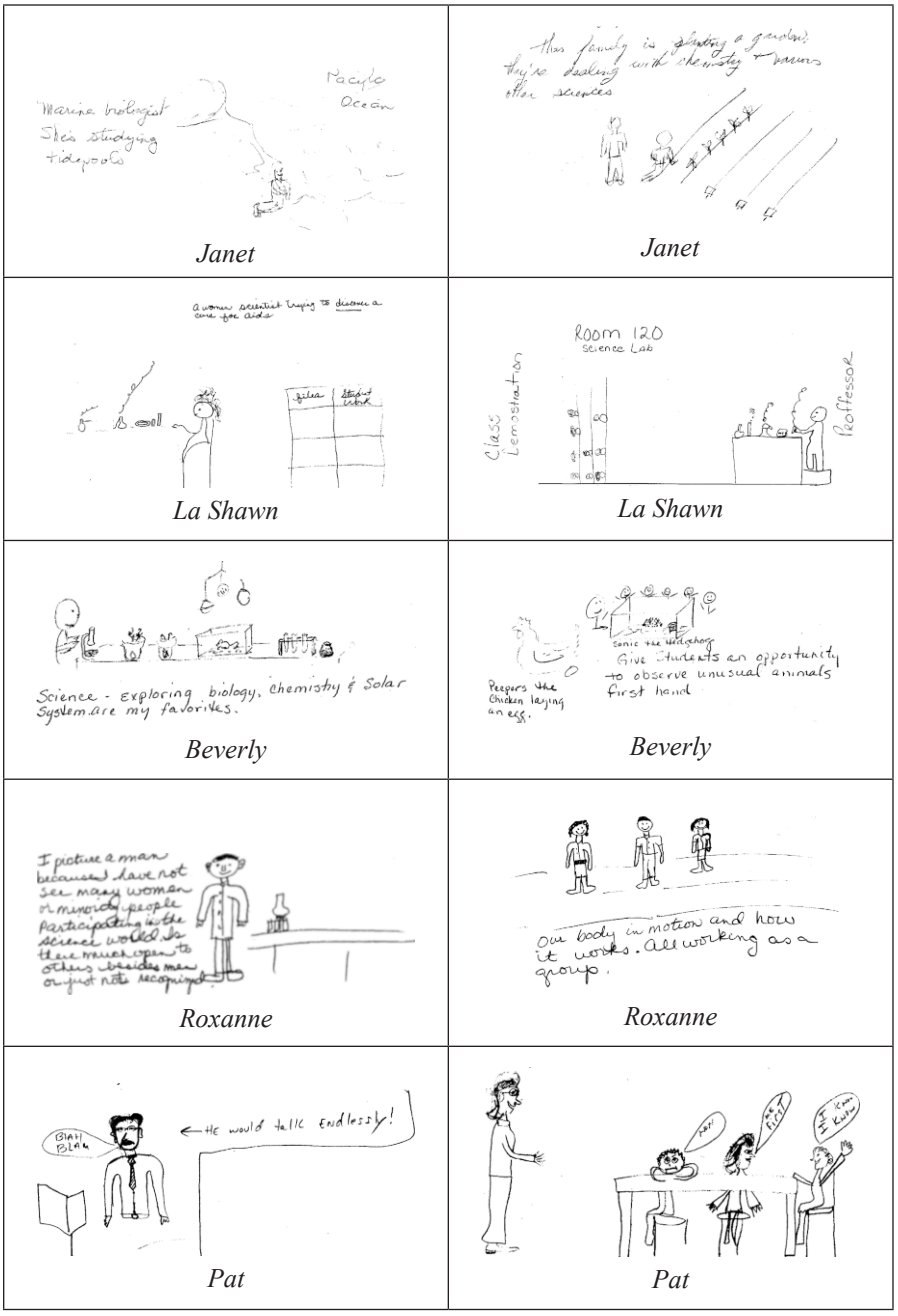


Figure 12.2. (Continued)

By the end of the first program session, five of the woman portrayed some group activity. "Group" was defined as more than one person in the image, depicting science as a social process. In the final drawings, nine of the woman drew two or more people in their illustrations.

Most of the afterschool program consists of group activities. The appearance of group science where solitary scientists were all portrayed in the first drawings suggested to me that the mothers' images were influenced by their experience. Since the mothers drew lone scientists at the start, it is possible that this persistent vision of how a scientist works is pervasive, but that alternatives are drawn when there are other opportunities to present images as experience accrues in alternate science settings. Most of the scientists were shown as "happy" or "neutral" in the last drawings.

DISCUSSION

I believe that identity development is an essential human activity as social beings (Wenger, 1998). I also believe that parents are highly invested in both their own lives and their children's' (Osterhaus, 2013; Trivers, 1974; Wilson, 1975). Science learning is how we acquire knowledge of the patterns in our world (Dewey, 1916; Kneller, 1978; National Commission on Excellence in Education, 1983; National Research Council, 2014; Rutherford & Ahlgren, 1990). It is this knowledge that helps our survival success. It follows that some parents would seek out opportunities to improve their success and their children's. I focused on mothers in this study because research continues to tell us that women are less confident and represented in science (AAUW, 2010; Avery & Meyer, 2012; Jung & Tonso, 2006). This program's work has shown promise for providing opportunities for mothers to include in their identities "afterschool science enrichment teachers"—"Adult Leaders" in our vocabulary.

This was a small study that was designed to have more generalizability by the broad range of participants from four geographical areas and varied ethnic and economic backgrounds. The voluntary nature of study participation introduces a bias. The mothers were willing to invest additional time in the study and were pleased to do that. We can assume that they were predisposed to enjoying their afterschool science participation and that does seem to be the case. How much of this predisposition to enjoy learning impacts on the reasons for the choice to affiliate with the afterschool science teaching community? Given that there are many choices for affiliation outside the home, the data support that the choice of this particular program was a conscious one to improve their science backgrounds for themselves and their families. They came to the afterschool science program already convinced that science was important to their lives. It would be useful to do research within their geographic communities to gain insights into the values and attitudes of other mothers who do not participate. Is this due to constraints of family, employment, other communities of practice in other interests, and/or resistance to science? Are

there other opportunities within these communities to gain the same teaching skills and confidence in science? Interactions with one's children scaffold or promote children's' development (Rogoff, 1990). The mothers who teach in the afterschool science program may be able to use their learning in their homes to their children's' advantage. Do mothers engage in out-of-school science without this support? In what ways and how do these compare with those who learn through teaching? These questions were beyond the scope of this study, but would shed light perhaps on how to make such scaffolded learning more available and also to see where work is needed on communicating the relevance of science in our lives.

There is always a balance between investing in oneself and in one's children (Trivers, 1974). The limits are defined by time and resources. When it is possible to overlap—that is, where taking care of oneself and one's children is simultaneous, there is both efficiency and reinforcement of the learning and its value. Learning is both complex and cumulative (Dierking et al., 2003; Tal & Dierking, 2013). In this sample I saw a group of women who were enthusiastic about learning new things—even if engaging in science was not part of their initial identity. The excitement for learning in general may explain a good part of their willingness to add "science teaching" to their identities. It also suggests a quality to assess in recruitment of mothers for communities new to them, in terms of out-of-school programming.

There is evidence that tells us that more educated parents can provide better for their children because they have more knowledge to pass on and because they tend to have better paying jobs that allow for wider resources for their families (Skolnick et al., 1982; AAUW, 2010). Scientific habits of mind provide benefits. They allow for thoughtful decisions based on evidence, evaluation of options for health, safety and other decisions as well as careers. Early development of these habits is helpful and cumulative. Mothers who can learn to teach science may create home environments conducive to their children's success and can point them in enriching directions. Participation in an afterschool program in a teaching-as-learning scaffolded situation is a small contribution to a household. Does this reverberate with bigger changes over time? For the women in this study, the inclusion in a community of afterschool science enrichment teaching meant that they presented themselves as such to their children. Our evidence shows that this impacted on the home environment that the mothers were creating in terms of science participation. Their involvement as women modeled for the children that women could enjoy science and engage in it. This would suggest that out-of-school science educators might consider expanding opportunities for "parent-as-teachers" apprenticeships, especially for mothers, to create supportive science teaching identities for them as role models and teachers of their children in their homes.

SUMMARY

We are all science teachers by the nature of being human, although not professionals. We further the effort by identifying as science teachers with the skills that brings.

Our science teacher identities need nurturing and support. One way to achieve this is to participate in a scaffolded situation, such as the afterschool teaching opportunity described in this chapter. There is evidence that the scaffolding and invitation to participate supported the identity building of the women who sought out this position as science teachers. I noted the process of identity building that was common to the focal women.

The evidence includes drawings. Drawings have active, reflective and historical elements. The illustrator makes an effort to make visible to others the mental model she holds of what science teaching is. The result helps to provide self-reflection. She also creates an artifact which we, as researchers can analyze and compare in the present. And then she leaves this evidence for others to see and learn from in the future. We know something of the activities of people who lived 15,000 years ago because they drew on cave walls. Women, mothers beyond this study may learn something of their cohort's thinking about themselves as science teachers because I have written this record and included drawings in a book to be read for some time.

Women who saw their core identities as mothers and came to teach and learn science because they were motivated by this core identity to provide what they thought was important to their and other children, came to see themselves and be regarded as out-of-school science teachers. Not experts, but facilitators. With the support of professional out-of school science educators, they were invited to become part of a community of practice in encouraging children to better understand the nature of science, to use the tools of science and to appreciate the pleasure of science in their lives. This research has provided further evidence of how identity development theory describes women who chose to transform themselves into part-time science teachers as one identity. This evolving identity interacts with their identities as mothers, as it does with the other identities they take on as they move among other groups. Their participation often overlaps and their identities are in constant interaction.

It would be difficult but contributive to seek insights among those who do not choose this path. Surely there would be practical reasons of work schedules and alternative family commitments. But it would be fruitful to know how non-participants think of themselves in terms of the role models and attitudes that they pass on to the next generation, if not participating in a community of welcome and support. The next generation spends formative years among their mothers. It is suggested that the participation in essential science education is impacted by what happens.

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