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ABSTRACT

Children have ample opportunities to learn about science outside of school through visits to science museums, participation in extra-curricular science programs, and by pursuing experiments at home, yet few studies have examined what it means to do science in such places and how such ways of knowing might become integrated with, or differentiated from, school science. In an attempt to fill this gap, a qualitative case study of an inner-city youth gardening program was pursued. The purpose of this study was to delineate the meaning of science as made and conveyed through the activities and the conversations in which participants engaged, and to determine whether participants shared the program's notion of science and perceived themselves as science practitioners. Findings suggest that the program provided opportunities to gather much factual and practical science knowledge that was very context-specific. In addition, results show that participants held very rudimentary notions of science which served as a yardstick for the assessment of the program activities as scientific. Garden work was perceived as entailing science only if it could be framed in terms of conducting an experiment or as engaging in observations. Despite participants' interpretation of gardening as having little to do with "real science," this paper concludes with a discussion of how an appreciation for and awareness of the natural world--two important components of scientific literacy--could be developed through garden work. Contains 36 references. (Author/WRM)

Is that Really Science? A Look at the Science Practice of an Inner-City Youth Gardening Program

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Abstract

Children have ample opportunities to learn about science outside of school through visits to science museums, through participation in extra-curricular science programs, and by pursuing experiments at home. Yet, few studies have examined what it means to do science in such places and how such ways of knowing might become integrated with, or differentiated from, school science. In an attempt to fill this gap, I pursued a qualitative case study of an inner-city youth gardening program. The purpose of the study was to delineate the meaning of science as made and conveyed through the activities and the conversations in which participants engaged. I was also interested in whether participants shared the program's notion of science and perceived themselves as science practitioners. Findings suggest that the program provided opportunities to gather much factual and practical science knowledge that was very context-specific. Despite participants' active sense-making in the program as evidenced by their questioning about science, they considered themselves as workers rather than science practitioners. It became clear that participants held very rudimentary notions of science which however served as a yardstick for the assessment of the program activities as scientific. Garden work was perceived as entailing science only if it could be framed in terms of conducting an experiment or as engaging in observations. Despite participants' interpretation of gardening as having little to do with "real science," the paper concludes with a discussion of how an appreciation and awareness of the natural could be developed through garden work, two important components of science literacy.

Children have ample opportunities to learn about science outside of school. Through outdoor play principles of physics can be explored (Fox, 1997). Scientific reasoning skills might be practiced during dinner table conversations (Ochs & Taylor, 1992). Science museums and extra-curricular science programs offer opportunities to engage in hands-on science activities that are intriguing and motivational, leading to better learning of science concepts and the development of positive attitudes toward science (Hofstein & Rosenfeld, 1996; Ramey-Gassert, 1997). Recent research by Korpan et al. (1997) provides further evidence that children do participate in a wide range of science-related activities outside of school such as watching television, reading, attending exhibits or events at community facilities, conducting experiments and demonstrations at home and asking questions of parents -- activities which are most likely conducive to the development of science literacy. Accordingly, "schools are not the only -- or perhaps even the primary -- source of [science] literacy competence" (Resnick, 1990, p. 182). Clearly, "people learn science from a variety of sources, in a range of different ways, and for a varied number of purposes" (Wellington, 1990, p. 247).

Everyday science literacy practices are also seen as practical, informational, and pleasurable and hence, differ in significant ways from traditional school science practices (Schauble et al., 1996). This recognition has led some researchers to propose the existence of different sub-cultures of science among which we ask children to navigate (Aikenhead, 1996). At the same time, some researchers caution that informal settings may contribute little to the accumulation of scientific knowledge. At their best, such places may lead to the public's awareness of and enthusiasm for science, which can be thought of, however, as a prerequisite or maybe even a component of science literacy (Wellington, 1990). In order to better understand the opportunities provided by informal settings for the development of science literacy, studies are needed that provide detailed accounts of such everyday science literacy apprenticeships. What it actually means to do science outside of school and how such ways of knowing might become integrated with, or differentiated from, school science has to be addressed. Only that way can we understand the significance of the daily border-crossing children engage as they navigate among school science and everyday science practices. Such research endeavors would also allow us to address whether "real science" gets done in other places than academically oriented science classrooms or programs.

This study attempts to fill this gap by examining the ways children talk and think about science in an inner-city youth gardening program I call City Farmers. The City Farmers program provided opportunities to gather plant science knowledge by growing marketable crops. Since participants also received a stipend for their gardening work, work ethics and valuable life skills could be taught simultaneously. Contrary to most summer programs, the City Farmers program was not driven by the intention to improve youth's school performance in science, and hence provided truly alternative occasions for science literacy practices (Resnick, 1990). What those occasions were and how they became enacted in practice through action and talk are addressed in this study. The City Farmers program is also interesting since it provides opportunities to do science to inner-city youth who are often alienated from school science and who also have few other opportunities to participate in summer programs.

Conceptual Framework

Underlying my approach to the study was the assumption that science is socially and culturally constructed through participation in communities of practice. Learning entails becoming fluent in the discourse, beliefs, and values about science shared within a community of practice (Gee, 1990; Latour, 1987). Inherent in a conception of science as a form of cultural knowledge is also the recognition that the meaning of science and being a scientist is constituted by practice (Eisenhart & Finkel, 1998). Accordingly, I focused on the activities that got done in the garden, on the tools participants used to make meaning of garden science (i.e., linguistic devices), and on participants' notions of science.

To understand the garden science practice, I drew upon the literature describing conventional school science practices. Central to such practices is the goal to gather evidence through observation and experimentation in order to predict natural phenomena (Duschl, 1994). Tools of the conventional school practice such as textbooks further reinforce such notions by presenting "science as a process of induction that proceeds smoothly without discontinuities until a self-evidently correct view is reached" (Hildebrand, 1998, p. 348). Class time may consist of a demonstration of new material by the teacher, copying of notes, reading of textbooks, some lab work, a whole class discussion, and a teacher summary

(Lemke, 1990). Lectures by the teacher are seen as important in order to provide students with the science knowledge they need (Roth, 1998). Students are asked to reproduce ideas of teachers and textbooks, and to put their own ideas and questions about science aside. Thereby, students learn that "school is not a place in which genuine construction and co-construction of meaning is valued" (O'Loughlin, 1992, p. 807). Not surprisingly, students come to perceive science as abstract and as a world distinct from their own (Aikenhead, 1996). Students assume that scientists, like them, arrive at solutions through applying the scientific method (Griffiths & Barman, 1995). A focus on the intellectual products of science rather than on the process of knowledge generation in the classroom also mystifies the relationship between theory and science. Since the conventional school science practice rarely considers fringe or contested science, few students understand the social processes through which knowledge claims are made (Driver, Leach, Millar & Scott, 1996). Accordingly, scientific laws come to be perceived as the most certain kind of scientific information.

Clearly, such activities and notions of science do not represent in any way scientists' work, as research in the history, philosophy, and sociology of science has shown (Duschl, 1994, Latour, 1987). Such notions of science are also no longer shared by innovative science programs that stress the social and cultural nature of science and science learning (O'Loughlin, 1992; Roth, 1998). Yet, traditional school practices, scientific text, media and other everyday experiences keep reinforcing an image of science as "socially sterile, authoritarian, non-humanistic, positivistic, and absolute truth" (Aikenhead, 1996, p. 11). The majority of City Farmers held such notions of school science which seems to suggest that their school science practices were most likely rather traditional (Rahm, 1998).

In contrast, a garden supports activities, ideas and places for science to get done that differ significantly from those that are part of the conventional science classroom (Francis, 1995). For instance, gardening purports to experiencing and interacting with the earth, plants and crops by acting, smelling, and tasting. There might be some overlap in the content however (Wood-Robinson, 1991). For instance, a curricular unit in plant science in school might provide opportunities to learn about plant identification and plant growth, two central components of garden science. Given some overlap in content, one would anticipate that City Farmers would be able to perceive the science embedded in the gardening activities and to think of gardening as related to, at least in some rudimentary way, to the school science practice.

In this paper, I begin with a description of what it meant to do science in the City Farmers program. I delineate the meaning of science by examining the kinds of activities the program supported and the kind of science knowledge they entailed. Next, I portray participants' descriptions and interpretations of garden science. By examining participants' notions of science in the context of the garden practice I attempt to answer the question of whether City Farmers did "real science."

Setting, Participants, and Procedures

Sponsored through 4-H, the City Farmers program was a community youth program that ran through the summer and helped students of all ages, genders, and ethnicities learn about central issues of plant science and entrepreneurship. The City Farmers program was an eight week summer program that met in a community garden, three half days for three and a half hours each day. While the focus of the City Farmers program was plant science -- seeding, growing, harvesting, and marketing herbs -- leadership skills and work ethics were also taught. The program was also often portrayed as a prevention program by the 4-H community in that it was tailored toward middle school inner-city children who are at risk of dropping out of school and have few opportunities to engage in other extra-curricular activities or summer programs. Although the City Farmers program was an educational program according to the program director, hourly stipends ($2.50) were provided to youth who participated. That lend itself to the teaching of work ethics and life skills (i.e., filling out of time sheets, being on time and responsible). The study was conducted in the third year of the program's existence.

The garden plot hosting the City Farmers program was set in an ethnically diverse neighborhood in a low income inner-city area. Through advertisements in a local newspaper and in neighborhood schools, youth were recruited for the program each year. Some also came back. Interested youth were asked to fill out an application form stating why they wanted to become part of the program. Twenty-three youth (twenty-one African American, two European American; eight female and fifteen male), ranging in age from eleven to fourteen years, participated in the City Farmers program along with four adult team leaders, two master gardeners, and the program director.

The eight weeks in the garden were structured around four activity settings among which teams rotated in a two week cycle: (1) nurturing, (2) harvesting, (3) marketing, and (4) special projects.[1] Since one of the program goals was for youth to develop team skills, the participants were to stay within the same team for the duration of the program. Prior to the gardening work, a three week training session (a fifth activity setting) was conducted in order to familiarize youth with plant science, work, and life skills inherent in the program. I followed one team of six youth with a video camera. It allowed me to record all the gardening activities of that team in each activity setting while also capturing the discourse that emerged as science got done. Clearly, the camera served as a note-taking tool, with the same purpose and subjectivity as the ethnographer's pencil and notebook (Jordan & Henderson, 1995). However, it seemed that all program members habituated rather quickly to the presence of the camera. In order to infer what it meant to do science in the City Farmers community, I then conducted a domain analysis of all my fieldnotes and developed taxonomies of the kinds of activities the program supported (Spradley, 1980). I also used my understanding of the kinds of activities schools support as an interpretive template. It led to a thick description of garden science consisting of vignettes and excerpts (VanMaanen, 1988; for further details see Rahm, 1998).

I also conducted individual semi-structured interviews of all team members at the beginning and end of the program in order to assess their notions of science (Spradley, 1979). The interviews focused on participants' notions of science and examined how participants talked about learning science in this program as opposed to learning science in school. At the end of the program, I also gathered semi-structured interviews with a similar focus of all the adults involved in the program. I draw from them only little in this report, and only to illustrate what could be learned about science in the program (for details see Rahm, 1998). The interviews were transcribed verbatim. I pooled the answers from all participants to a particular question and searched for patterns inductively (LeCompte & Pressley, 1993). By carefully verifying interpretations of the interview data, re-examining and reviewing transcripts, interpretations emerged from the data rather than being of anecdotal nature. In order to support my interpretations, I identified discourse segments in the interviews that helped develop my story line.

[1] In this paper, I only discuss the science practice embedded in nurturing, harvesting and marketing.

What It Meant To Do Science In The City Farmers Community

Tamara is about to plant Swiss chard in a small pot that is filled with potting soil and calls out, "I need a ruler." Buddy is busy potting his seeds and wonders, "why do you need a ruler?" Tamara responds quickly, "because it said half-thirteen millimeter... that's a lot deep!" Tarr who just finished potting his seeds has some advice, "just stick your finger in there and see!" Tamara wondered, "my finger? The first one? Not including my finger nail?"

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It is our first day in the garden and Marc, the Master Gardener explains: "Here in the raised beds area we grow most of the herbs the market wants. And some of the herbs are annuals and some of them are perennials. Behind us are most of the annual types like dill and cilantro, and right in front of you are most of the perennial types like chive and tarragon." Marc asks Coretta to rub her finger against an oregano leaf. He wanted to know what it smelled like and whether it reminded her of anything. "Maybe tea" Coretta offered? "Close, I think of a nice pork pot roast. Lot's of herbs and stuff! One of the things we need to do here is, we need to learn how to identify plants." He brakes off a couple of stems from the huge chive plant and asks Marti "what does it smell like to you?" "Onions" Tamara interjected. Marc confirmed, "onions is right, chives are related to onions. It is kind of like a mild onion."

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Tarr was asked to harvest green salad leaves. After some thought, Estelle advised him to "actually pull out the Valeria lettuce." That lettuce was approaching the end of its harvesting season. Will was about to do the same with the Simpson lettuce, but Estelle stopped him just in time, "I don't want you to pull them out. What you have to do is going down (to the root) and then pick out the leaves. I know it is kind of tedious." Estelle demonstrated what she meant and added, "remember how I told you to pick the whole leaf?" That was important in order for the product to be marketable. Marti was done with the spinach and was now asked to harvest some collard leaves, "let's do about ten leaves." Tarr was wondering about the looks of a salad leaf. Estelle reminded him, "you don't want it jagged. You want it like...," she picked one and held it up so Tarr could see. Estelle explained, "you see this one is nice and round all over. You want that rather than this." She picked up another leaf, a bad model ,and held them both in the air side by side.

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Will is busy washing cilantro, "a long dragging process." Nannie is washing salad leaves and just found a bug. Estelle, the team leader, reminds everybody to do "quality control." Estelle gives some paper towels to Will so he can spread out the wet cilantro. "I thought we would use the drier?" "Well, yeah, but Tarr is using it so why don't we just go with the towels" Estelle suggests. "So I am gonna put it on the paper towel, and then bag it and then weigh it?" Will asked. Estelle *corrects, "how about you first weigh it," Marti is about to weigh the basil and verifies with Estelle, "one ounce?" Estelle confirms, "yeah, you guys know how to measure one ounce, right?" Marti mumbles "yeah, OK, one ounce" as he is about to load the scale with basil leaves.*

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These four vignettes depict the forms of science practices particular to the City Farmers community. Opportunities to plant seeds, as illustrated in the first vignette, emerged in training and nurturing. In order to be successful, City Farmers needed to know the name of plants they were to grow from seeds, how far apart, and how deep seeds were to be planted -- all of which I took to mean factual science knowledge. Factual science knowledge, however, was not enough to do the gardening work. In addition, much practical science knowledge had to be mastered. For instance, City Farmers needed to know how seeds were to be planted, and how spacing and depth for planting were to be determined. As the vignette illustrates, Tamara struggled with mastering the practical science knowledge particular to this setting (i.e., determining planting depth by use of finger rather than ruler). Note how Tarr's feedback suggests a less precise, and maybe less scientific practice of determining depth of planting than Tamara had envisioned. Yet it was this kind of practical contingent precision that was called for in gardening. Tamara's initial attempt at planting with a ruler might be an illustration of transfer of school science knowledge (i.e., using a ruler to determine plant depth) to the garden. That is, planting in a science classroom might be driven by the goal to complete the steps listed on a seeding package without considering the practical implications of those steps. In contrast, expert gardeners know how to translate such "exact" planting information into practice in a way that is meaningful and practical (i.e., using finger to determine planting depth). Hence, exact science as is typically emphasized in conventional science classrooms was not of value here (e.g., use of ruler for planting). Instead, one had to be precise enough in a practical sense.

Another important form of science practice entailed the identification of plants in the garden, as the second vignette illustrates. Contrary to science classrooms however, plant identification was not done by careful examination of the leaf structures of plants, but instead, the use of the senses was emphasized. City Farmers were encouraged to taste and smell plants in order to identify them. When physical features were noted, the focus remained on a plant's general structure. For instance, dill was considered to look somewhat "bushy" and maybe like "a cactus." Hence, City Farmers had to know the names of plants (factual science knowledge) and be able to make use of their senses to identify and differentiate plants (practical science knowledge), a very different form of plant identification practice if compared with a conventional science classroom where abstract classification in terms of structure and function are emphasized (Jantzen & Michel, 1989).

Plant identification also figured into harvesting activities as the third vignette indicates. Here, Estelle, the team leader, taught City Farmers different harvesting techniques. Almost every kind of crop entailed another method depending on the kind of crop it was (plant identification) and the time of year. City Farmers were also reminded to only harvest crop that was marketable and looked nice. Note also that much of the teaching by the adults was done through demonstration and little talk. Knowing how to harvest the different crop was taken as representative of practical science knowledge. In fact, much practical science knowledge had to be acquired by observing experts such as Estelle and by doing it under her guidance.

The fourth vignette illustrates the processing and packaging procedures a City Farmer had to master. As with harvesting, such methods varied depending on the product and entailed the pursuit of a number of steps (washing, drying, weighing, packaging). At first sight, processing and packaging might not seem to have much to do with science. However, in order to pursue the right kind of processing technique, City Farmers needed to identify the herb (i.e., engage in plant identification). For instance, cilantro was to be washed and sold in bunches whereas basil would loose its taste if washed and simply needed to be weighted and checked for bugs and rotten leaves (i.e., quality control). Accordingly, factual and practical science knowledge were also embedded in different ways in the program activities.

Table 1 illustrates that garden science consisted of much factual and practical science knowledge, gathered through participation in nurturing, harvesting, and marketing activities that were part of the program. The factual science knowledge had practical and local purposes and was to be integrated with the context-specific practical science knowledge without which City Farmers could not have achieved the goal of growing marketable crops. Given such a program goal, efficiency or getting the job done was emphasized by the adults and not necessarily learning or trial-and-error exploration typical of formal schooling (Guberman & Greenfield, 1991).

Table 1

Learning Opportunities in Science And The Role of Factual and Practical Science Knowledge

Learning Opportunities in Science	Goal	Factual Science Knowledge	Practical Science Knowledge
Planting of Seeds	•To grow a plant that produces marketable crops	•Name of plants •Planting Instructions	•Knowing how to plant seeds •Knowing how to transplant seedlings •Knowing how to nurture plants (i.e., watering)
Plant Identification	•Weeding •Harvesting •Processing crops •Packaging crops •Marketing crops	•Name of plants •Knowing characteristics of plants (use, smell, looks)	•Knowing how to identify and differentiate plants
Tool Use	•To be able to use tools effectively to get gardening tasks accomplished	•Name of tools •Knowing which tool to use for what purpose	•Knowing how to use tools effectively
Watering	•To grow a plant that produces marketable crops	•Knowing of different watering methods •Knowing why to water in a certain way for a certain plant	•Knowing how to water
Weeding	*To make space for crops to grow into marketable produce	•Names of plants •Knowing differences between plants and weeds •Knowing reasons for weeding	•Knowing how to identify and differentiate plants from weeds •Knowing how to weed effectively
Harvesting	•To prepare marketable crops	•Names of plants	•Knowing how to identify crops that is ready to be harvested •Knowing how to harvest different plants
Plant Processing	•To prepare marketable crops	•Names of plants •Processing options	•Knowing how to identify crops •Knowing how to process crops (wash, weigh, quality control)
Plant Packaging	•To prepare marketable crops	•Names of plants •Packaging options	•Knowing how to identify crops •Knowing how to package crops (kinds of bags, labels)
Marketing	•To sell crops	•Names of plants •Knowing characteristics of plants (use, smell, looks) •Processing options	•Knowing how to identify and differentiate plants

Note some overlap between the kinds of learning opportunities the City Farmers program supported and that which are typical of school science, such as activities pertaining to plant growth and plant identification. Despite some overlap in content, Table 1 makes apparent that the goals inherent in each learning opportunity listed made the activities context specific nevertheless. For instance, in school, plants might be grown in order to learn about their needs, whereas in the City Farmers program, plants were grown in order to produce marketable crops, suggesting a focus on the product rather than process of growth. Given such differences in the goals underlying the growth of plants, for instance, the kind of factual and practical science knowledge each setting stressed varied also. Table 2 provides a summary of the characterization of factual and practical science knowledge in the garden and in school to further highlight the context-specificity of garden science.

Table 2

Factual and Practical Science Knowledge in Garden Science and School Science Practice

	Garden Science	School Science
Characterization of factual science knowledge	Factual science knowledge that is universalistic is not valuable or necessary	Factual science knowledge that is universalistic is very valuable and necessary
	Factual science knowledge has practical and local purposes Example: Plant identification crucial to goal (marketable crops)	Factual science knowledge has generalized purpose Example: Plant identification crucial to goal (theoretical understanding and manipulation)
Characterization of practical science knowledge	Practical science knowledge that is context-dependent is very valuable and necessary	Practical science knowledge is neither very valuable nor necessary
	Factual and practical science knowledge is sometimes visible and sometimes embedded in work	Factual and practical science knowledge is marked and hence, made visible
General features	Contingent practical precision is emphasized	Scientific precision emphasized (no room for error)

Factual and practical science knowledge are part of both garden science and school science. However, garden science relied heavily on context-specific practical science knowledge (and some context-specific factual science knowledge), whereas school science emphasizes factual science knowledge that has a general purpose. Contingent practical precision is central to gardening whereas scientific precision and rigor is emphasized in the science classroom. Furthermore, science is embedded in gardening work, whereas it is highly visible in the classroom since the activities are marked as "doing science" by the teacher. Such differences are not surprising given the goals of each practice. In the garden, enough science knowledge had to be acquired to grow, harvest, and market crops -- immediate and concrete goals. In contrast, the science knowledge to be learned in school has a more general and far-reaching goal of mediating future education, or, simply, the development of scientific habits of mind. Accordingly, in the garden and the school setting, science was a means, but a means to different ends.

Now that I have characterized garden science, I turn to participants' descriptions of garden science to show whether gardening was considered as doing "real science."

What Could Be Learned About Science In Youths' Words

To portray City Farmers' notions of science and, in particular garden science, I begin with a description of youths' talk about the similarities and differences between school science and garden science. When asked "do you think learning about plants in school is the same or different from learning about plants in this program?" all informants found ways to differentiate the two practices and could easily articulate differences in terms of the science knowledge central to each practice.

Some City Farmers ascribed the main difference between garden science and school science to the curricular content. In fact, many City Farmers never studied plant science in their science classrooms. That is not surprising, given the fact that the science curriculum in the U.S. is fragmented and lacks focus (McKnight & Schmidt, 1998). Nannie referred to the many kinds of sciences she covered in her classroom:

Excerpt 1

JRENE:	So how was learning about science different or the same from learning about science in school?
Nannie:	We didn't learn about no plants at school. We learned about all this make babies and stuff... and drugs. That's what THEY call science.
JRENE:	Uhm mmh. So do you think what they call science is different from here?
Nannie:	There's a lot of different sciences, science, because my grandpa's a scientist. He found out why, what causes strep throat and he was in the paper and he won some money and stuff. But there's science about dinosaurs and plants and animals and people and planets and all kinds of things. [INTV]

Nannie's school science activities entailed talk about "make babies... and drugs" which she referred to as what "THEY call science." Then there is "science about dinosaurs and plants and animals and people and planets and all kinds of things." In support of her vision of multiple sciences, she talked about her grandfather who was a scientist and discovered the cause of an illness. Her personal experiences, in addition to school, influenced her way of thinking about science, a common finding (Costa, 1995). Nannie's response suggests that plant science was maybe not part of what "THEY call science." Her emphasis on "THEY" suggests that her view might differ. Maybe plant science was just another kind of science for her, but apparently not a kind valued at the school she attended.

In contrast, Stephen provided a description of the plant science curriculum in his school, a description that captured the school science practice experienced by most City Farmers:

Excerpt 2

Stephen:	The way that we worked with plants is, in school, we dissected them, see what was inside. See the stem, how they, how they feed for water and sun and soil. That's it.
JRENE:	You think how you learn about plants in school is the same or different from how you learn about plants in this program?
Stephen:	Is different.
JRENE:	What makes it different?
Stephen:	In school we just learn about how they feed, how it sucks, sucks in water or air and this program we get to learn how to, how it, what do I want to say, how it, how it germinates, how it needs sun, water, soil, things like that. [INTV]

Stephen's comment about his school experience suggests that he learned various facts about plants (e.g., what makes them live, how plants grow from seeds) but nothing about the practical aspects of getting plants to grow (e.g., how it germinates, how it needs sun). Stephen also never learned the practical implications of these facts (i.e., how they might inform decision making in the garden as seeds are planted). As noted by Lave (1985), "school problems seem designed primarily to elicit the learning and display of procedures" (p. 174) or put differently, decontextualized factual science knowledge (Duschl, 1994). In contrast, in the City Farmers community, science was employed to produce marketable crops and learned through engagement in purposeful activities. Thereby, the practical implications of factual science knowledge could be gathered.

It suggests that Stephen was aware of a difference in focus the two settings seem to have. Yet, it was not solely a difference in content or focus, but also in the level of detail, that set the two settings apart according to youth. Most of the informants argued that the time spent on understanding the life cycle of a plant, rather than simply its parts, differentiated the two settings:

Excerpt 3

JRENE:	Do you think learning about plants in school is the same or different from learning about plants in this program?
Will:	Well, it's different because school, they were just telling you the basics about plants, they weren't like going into any details, but this program is all plants, so they like know more about plants than the school does. [INTV]

Will pointed to the central role plant science played in the City Farmers context, and how this amounted to a very different science practice than in the school context. In addition, Will seemed to contend that the program taught details about plants, which suggested to him that the program "know[s] more about plants than school does." Will's note about details might underline the kind of practical science knowledge the City Farmers program valued.

It was surprising that City Farmers were so articulate about differences between garden science and school science, if City Farmers had such few opportunities to engage in activities pertaining to plant science in school in the past. Yet, youths' talk focused mostly on differences in how science gets done in the two settings, rather than on plant science per se. As Tamara put it, "Here, they put you through it and at school they just put it on paper." Later she added, in school "they just teach us, they don't show us," a statement made by many others, too. Benita put it her way, "[Here] you get to do the whole package!" Similarly, Tarr and others noted, "Out in the garden [we are] like doing it ourselves and then like in school... we just talk about it." And because of that, Stephen added," I think I learn more in this program than I'll ever learn in school."

Accordingly, what Will and Tamara might have tried to convey is the program's emphasis on learning by doing (i.e., experiential and hands-on). City Farmers seemed to value the hands-on approach of the program, which led to purposeful and meaningful activities in which science content was embedded and details could be learned. This also suggests that City Farmers were aware that the kind of science knowledge the program emphasized differed from school. They seemed to know that talking about science in classrooms led to the accumulation of factual science knowledge, whereas doing science in the City Farmers program supported the development of factual and context-specific practical science knowledge, the latter being of particular value. Evidence for that interpretation is provided by Marvin:

<u>Excerpt 4</u>

JRENE:	How is learning about plants in school the same or different from learning here?
Marvin:	I haven't learned that much about plants in school and if there is anything about plants, all it does is tell you how much oxygen the flowers can take or how much a tree could take so that's about it.
JRENE:	So do you think how you learn about plants is the same or different in this program from school?

Marvin: Is different. You learn more in this program than you would from schools, well from my school because I don't think my school is, my school doesn't teach that, all of that stuff, how to plant so I would say this program would be better or different from school because you would learn more in this program than you would in that part of school about plants.

JRENE: Uhm mmm. Why is that? Just because you don't cover plants in school?

Marvin: Just because they don't cover as much as the program does and in school they don't tell you, you know, you're supposed to plant this and this so deep. You know, you're just supposed to plant this and plant that. That's all they usually say so, you know, in the garden they'll say, you know, you're supposed to plant it here and here and here. Don't dig that trench too deep or just dig it right on the corner. Use the edge of the hoe just to make a trench or something like that. So I say you would learn more in this program than you would in school about plants. [INTV]

Marvin argued that more could be learned about plant science in the program than in school, not just because the program's focus rested solely on plant science, but given the way science got done. Marvin described the kind of practical science knowledge the program valued and that was specific to this setting. For instance, "use the edge of the hoe just to make a trench" illustrates the kind of practical science knowledge the City Farmers program emphasized. Marvin's talk also points out the kind of precision that was valued and implied in the practical science knowledge he gathered through participation in the program. For instance, by noting "you're supposed to plant it here and here," Marvin emphasized the fact that planting was not just an arbitrary process but that contingent practical precision was called for. Accordingly, the emphasis on context-specific practical science knowledge in gardening set it apart from school science for Marvin. In school, he was simply told "to plant this and to plant that." Here, such practices were not enough, which seemed to suggest to Marvin that he learned more about plant science in the program than in school. In fact, to know how to plant was important. Otherwise planting would not necessarily lead to the growth of crops. Hence, participants' descriptions emphasize the ways conventional science classrooms stress decontextualized factual science knowledge, whereas the program emphasized context-specific factual and practical science knowledge that could be gathered through involvement in purposeful activities in a community garden.

Participants' comparisons also supported a distinction made by Lave (1990) between the transmission of knowledge typical of schooling, and the acquisition of knowledge typical of informal learning environments. The former reflects a "culture of acquisition" that promotes the acquisition of abstract thinking that is supposed to be decontextualized and generalizable. In contrast, the latter entails "learning in practice." Accordingly, learning is socially and culturally constituted, and mastered through participation in the actual process of doing. City Farmers were aware of and able to articulate that difference. That awareness led them to identify the City Farmers community with "learning in practice" (Lave, 1990).

According to City Farmers, it was the content (focus on plant science only), the nature of learning (hands-on), and the underlying meaning of science (factual and practical science knowledge acquired through purposeful activity in a garden) and goals of the activities (to grow marketable crops), that separated these two science practices. When asked more specifically what could be learned about science in the program, youth provided extensive lists of program activities that pertained to the successful growth of plants and hence, made them scientific. For instance, Coretta noted, "I learned that plants have to be watered just, not too much and not too... not too less or they won't grow right... and they have to be, if it's a certain kind, like the turnips had to be planted four inches apart with the little dot in your finger." Here, Coretta described the care plants needed, and emphasized the importance of knowing the spacing and the depth for planting, referring to the kind of factual and practical science knowledge central to the program. By noting how a finger could be used as a measuring tool to determine plant spacing, Coretta also stressed the role of contingent practical precision (using finger). To take care of plants was also considered to entail science by Benita. She noted, "I learned that you have to... the tops of the basil you have to pick off because... they'll make the basil sour... it won't taste as good if it's sour." Benita's description is illustrative of the way context-specific factual (i.e., knowing why tops of basil need to be picked) and practical science knowledge (i.e., knowing how to pick the tops of basil off) had to be integrated in order to become useful. Removing the tops of basil was an activity that led to the growth of marketable crops and was considered as doing science by Benita.

Clearly, City Farmers took activities pertaining to the growth of plants as entailing science. Yet, once a plant had grown, the science stopped! One may wonder about City Farmers' notions of science that might have led to such an interpretation of the program activities. By asking more specific questions about program activities, I could examine their notions of science. Table 3 provides a summary of the questions and answers.

Table 3

Answers to Statements Specific to the City Farmers Community [n=6[2]]

Setting	Statement	Yes	No	Miss
Nurturing	When you work in the garden and plant seeds, is that doing science or not? Why?	83%	17%	0%
	When you make compost, is that doing science or not? Why?	83%	0%	17%
	Is knowing which gardening tool to use part of science or not? Why?	66%	17%	17%
Harvesting	Is harvesting plants part of doing science or not? Why?	50%	17%	33%
Marketing	Is selling herbs part of doing science or not? Why?	0%	67%	33%

Note: "Miss" refers to missing data.

Interestingly, planting seeds, doing compost, knowing which gardening tool to use, and harvesting plants were all activities identified as entailing science. It suggests that not only activities pertaining to plant growth were identified as science. Instead, it became clear that as long as program activities could be reframed as an observation, experiment, or entailing tool use, participants considered them as doing science. For instance, Nannie noted that nurturing entailed science "because you're making like an experiment to see if it grows." Doing a compost also entailed science according to Buddy, since it is like "doing an experiment, seeing if it 's going to work so I think that's science." That is, by putting different kinds of materials together one is "seeing if" the compost is really "going to work" (i.e., whether one is really getting compost or just a pile of stuff). Knowing which gardening tool to use was considered essential for being successful in a science experiment, as Tarr's statement makes clear, "Yeah, you have to know which one you're going to use or it can kill the plant or it could ruin the soil." According to Will, looking at the outcome of plant growth made harvesting scientific:

Excerpt 5

Will: Yeah because you're, you're looking at the conclusion of what the outcome of the plant... you see what the nurturing team did, like if they grew it. You get a chance to find out what they did... they might even have to taste it to see if it's good... or if the buyer wants to buy it or not. [INTV]

According to Tarr, harvesting also entailed certain science skills:

Excerpt 6

JRENE: Is harvesting plants part of doing science?
Tarr: Yeah.
JRENE: Why?

[2] I only collected answers to these questions from the team I followed in my study.

Tarr: Because, oh, a lot of different reasons. You have to, you have to know what you are doing, well, you kind of have to know what you're doing to harvest them.
JRENE: Uhm, mmmh.
Tarr: You have to know what time of year and that's by scientific inference. [INTV]

The statement that "you kind of have to know what you're doing" when harvesting attests to the fact that some knowledge was needed to do harvesting. By using the term "scientific inference," Tarr marked his description with the science genre indicating that harvesting might entail science. Thereby, Tarr suggested that deciding when to harvest (what time of year) might involve the making of a scientific inference, and hence, doing science.

These excerpts suggest that participants used notions of experimentation, observation, and tool use as frames of reference for deciding when work in the garden entailed science. For instance, the making of a compost pile was considered as an experiment by Buddy since one is "seeing if it is going to work." To then make it work leads to the resolution of the uncertainty an experiment implies. Will referred to another characteristic of experiments:

Excerpt 7
JRENE: When you make compost, is that doing science?
Will: Yeah because we're waiting for it to dry out so that we can put it back in the ground for good soil, to enrich it. We're basically doing that to determine the outcome of the soil. [INTV]

For Will, experimental work entails determining something. There is an assumption that something is unknown and needs to be figured out. Uncertainty was certainly inherent in nurturing work. At the time of planting, it was not yet clear whether the seeds and seedlings would eventually produce marketable crops. Instead, this had to be determined. Activities in nurturing and harvesting also supported observations. Through observation, one could determine "how different plants grow and learn about the different kinds of plants," in Buddy's words.

City Farmer's emphasis on observation, experimentation and tool use suggests that their notions of science were rather elementary. Yet, City Farmers used these rudimentary notions of science as a template to interpret the program activities as entailing science or not. Unfortunately, this resulted in youth being oblivious to the embedded nature of science in program activities pertaining to harvesting or marketing. As Tamara noted, "in marketing you're just trying to sell and market what you're growing, it's not very much science." Only when program activities had to do with plants and could be reframed in terms of observations, experimentations, and tool use (which was possible of nurturing activities) were they considered to entail science. Not surprisingly, City Farmers came to perceive themselves as workers rather than science practitioners.

Is That Really Science?

According to the participants, few of the program activities entailed science. I ascribed such an interpretation to their rudimentary and narrow notions of science, which served as a template to interpret only activities pertaining to plant growth as scientific. In contrast, my description of the garden science practice showed in what ways science knowledge was embedded in all program activities, making science a central unifying component of the mini-practices of nurturing, harvesting and marketing . To do science entailed invoking much factual and practical science knowledge particular to this setting. Like other informal science practices, the City Farmers program emphasized action, or putting factual and practical science knowledge to use. In contrast, school science practices often stress the acquisition of science knowledge for its own sake (Aikenhead, 1996).

Wertsch (1998) put forth ten claims that characterize mediated action and cultural tools and their internalization of which two are relevant here. First, Wertsch describes internalization as mastery or "knowing how'" which is a good way to summarize the kind of science knowledge (factual and practical) that could be gathered through participation in the program. That is, City Farmers became masters of many skills or procedures essential to gardening. Through participation in the garden practice, they came to know how to do gardening. In addition, Wertsch proposes a more psychological and less material based way of knowing that occurs through appropriation of mediational means. Appropriation is used "with the understanding that the process is one of taking something that belongs to others and making it one's own" (Wertsch, 1998, p. 53). So far, I have discussed the kind of science knowledge that was mastered by City Farmers. In order to determine whether garden science entailed "real science" I now discuss what could be appropriated through participation in the garden practice or "made ones own" by use of some excerpts from the adult interviews.

One of the team leaders described the kind of science that might be learned through participation in the program as follows:

Excerpt 8

JRENE: OK. Do you think learning about plants is doing science?
BILL: I do.
JRENE: Why do you think so?
BILL: Well because of a variety of reasons but I think plants are part of the whole ecosystem, Mother Earth, the planet, however you want to describe it. And so the more we learn about each aspect of that, the better we as individuals are. Also I think it helps kids to learn about different plants so they can appreciate everything that grows around, you know. Rather than just walk to school in the morning thinking about their hair or not having basketball practice or whatever, you know. They might look around and say, wow, you know, that is an elm tree and it's got Dutch elm disease and we're going to have to tear it down because it's going to die. But if we put up something else, in 10 years we'll have a new tree. Maybe something like that would get an impact.

Bill's statement suggests that the City Farmers program provided opportunities to develop a general orientation towards science. That is, through participation in the City Farmers program an attitude towards life and the world and an understanding of its fragility might have been developed. That might lead to actions such as the planting of an elm tree. Accordingly, through engagement in gardening activities, participants might have appropriated an appreciation of their environment.

By growing herbs and vegetables, City Farmers might have also gathered a sense of "how a plant goes from seed to plate," according to one Master Gardener. Similarly, another team leader noted:

Excerpt 9

JRENE: Do you think the kids also learn stuff about plant science in the garden?
CHRIS: They've told me things like, oh they didn't know such and such was grown from a seed. And I remember talking with two of the kids, they were picking chamomile tea one day, you know, and they were just in awe that these little flowers were the tea and stuff. Things they hadn't known, yeah. Just the fact that they liked watching it grow was enough reason, you know, for them to be there.

Chris described the kind of learning opportunities the program provided given its setting (garden) and focus on plants. To observe how a plant grows and produces crops that might be of relevance in one's life (chamomile tea) makes for a very different learning environment from the conventional science classroom. Few opportunities do exist for inner-city children to make these kinds of connections. Accordingly, through participation in the City Farmers program, youth might have also appropriated a sense of the cycle of food and life in general.

Clearly, learning the value of planting a tree, as described by Bill, or understanding the origin of chamomile tea, as expressed by Chris, is not the kind of science knowledge or attitude towards science traditional school settings support or value. Yet, as noted years ago by Montessori (1912), "gardening leads children to the intelligent contemplation of nature, as well as an awareness of and appreciation of their environment" (quoted in Alexander et al., 1995, p. 260). Or put differently by Francis (1995), "gardens are places to develop ideas and attitudes toward the natural and built world" (p. 183). Yet, is an awareness, appreciation and understanding of the natural world part of science literacy, or what might be called "real science?" The American Association for the Advancement of Science (AAAS, 1989) describes one characteristic of a scientifically literate person as being "familiar with the natural world" and as being able to recognize "both its diversity and unity" (p. 4). Accordingly, it can be argued that "real science" did get done and could be appropriated through participation in the City Farmers community.

The quote by Bill also suggests that the City Farmers program might have supported the development of activists of sorts (e.g., planting new tree), or, of concerned (or conscientious) citizens who are able to use science knowledge as a tool for action (Eisenhart & Finkel, 1998). Some researchers who question the schools' current emphasis on the production of laboratory scientists perceive such identities as more productive and desirable (Eisenhart, Finkel, & Marion, 1996; Roth, 1998). To do science "would mean that students participate in activities that contribute to the community at large" (Roth, 1998, p. 13). Clearly, by having City Farmers grow and sell crops in their neighborhood, youth themselves made a significant contribution to their community. They came to appreciate the value of a community garden or "green lung" in the City and could share their enthusiasm with others in their neighborhood and get them to participate in the program in the future. City Farmers might also be able to contribute to their own community in the future by tending their own gardens and lawns, by being conscientious about their environment and waste, and by understanding the cycle of life and teaching others about it. Ironically, if schools would stress the development of such an identity, school science and garden science could also be perceived as complementary rather than distinct, and City Farmers would maybe come to "see" the science embedded in the gardening activities.

This paper pointed to many intriguing issues about learning science in informal settings and science literacy in general. On the one hand, I noted the educational value of the City Farmers program, in that it led to many learning opportunities in garden science that were of value and interest to inner-city youth. At the same time, youths' rudimentary notions of school science served as powerful filters for the interpretation of the program activities, which led to the perception of the program as having little to do with "real science." Accordingly, my findings raised multiple questions that need to be addressed if progress is to be made in producing science literate youth: What opportunities can be provided to youth to develop, examine, and link multiple notions of science, to make possible for them to understand and appreciate the relationship between science and their everyday lives, and to help them use science to make informed choices in the future?

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