Creating Relevant Science through Urban Planning and Gardening

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Abstract: The purpose of this article is to describe a community-based science project that was coproduced with urban teenagers and to elaborate on my understanding of what it means to create a *practicing culture of science learning*. This understanding will be positioned in relation to various educationally relevant discourses and research on urban science education, concluding with an exploration of these questions: In what ways did an urban planning and community gardening project help to create a learning environment in which science was relevant? To whom was science relevant and toward what ends? It is argued that in a practicing culture of science learning, science was relevant because (a) it was created from participants' concerns, interests, and experiences inside and outside science, (b) it was an ongoing process of researching and then enacting ideas, and (c) it was situated within the broader community. © 2001 John Wiley & Sons, Inc. J Res Sci Teach 38: 860–877, 2001

Introduction

Students frequently report that what they learn in school has little relevance to their lives outside the classroom or to their futures (Nieto, 1994; Sleeter & Grant, 1991). This is particularly evident in school science, which typically reflects middle-class experiences and excludes the lives of students most on the margins of science (Atwater, 1996; Lee & Fradd, 1998). From a sociocultural perspective the relevancy of school learning can be understood by comparing the ways in which people learn inside and outside school. Such comparisons illustrate that traditional school environments do not match the ways that people learn outside school (Lave, 1988; Resnick, 1987; Saxe, 1990). School learning is often an individual endeavor of manipulating symbolic knowledge that is abstracted from everyday life. Achievement in this context is based on one's capacity to gather and remember the correct answers. In contrast, learning outside school involves shared reasoning and activity situated in real-world cultural

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contexts. Learning is a dynamic and recursive (rather than mechanical) process of constructing meaning (Rogoff & Chavajay, 1995; Vygotsky, 1978). Imported into the science classroom, this constructivist approach stresses the importance of a community of learners engaged in collaborative exchanges of science knowledge, discourses, and practices (Newman, 1990; Roth, 1998). Classroom science should promote "a learning environment in which students are engaging in learning activities consistent with current psychological, philosophical, historical, and sociological conceptions of the growth of scientific knowledge" (Gitomer & Duschl, 1995, p. 1). In short, students should have opportunities to engage in the *culture of science practice*, to participate in the ways of thinking and doing science. School science is relevant to the extent that the curriculum and classroom activities reflect what scientists do.

Reform efforts in science education have clearly articulated a vision of scientific literacy that moves beyond the acquisition of disparate facts and figures (American Association for the Advancement of Science, 1990; National Research Council, 1996). A constructivist approach to classroom science supports these reform articulations because students learn science as active constructors, rather than passive recipients, of knowledge. As students negotiate their understandings in science in collaboration with teachers and peers, critical thinking becomes the dominant mode of learning over the rote memorization of facts. However, science educators from feminist and multicultural traditions suggest that constructivist methodologies might not go far enough if the nature of science itself remains unchallenged. School science has typically not included the diversity of achievements, perspectives, and ways of knowing in science, or the experiences inside and outside science of students who are from groups typically underrepresented in science (Atwater, 1996; Barton, 1998a; McShane & Yager, 1996; Rodriguez, 1998). As such, the nature of "real" science, who one must be to participate in it, and the methods by which scientific knowledge claims are made must be critically questioned if science is to be relevant to all learners (Barton, 1998a; Eisenhart, Finkel, & Marion, 1996; McShane & Yager, 1996; Rodriguez, 1998). Rather than engaging students in a preconceived notion of science, critical science educators are finding ways of expanding the boundaries of Western science to include the multiplicity of students' perspectives and lived experiences (Atwater, 1996; Barton, 1998b; Seiler, 2001). Science and science education are relevant to the extent that student constructions in science include diverse perspectives and understandings of the world. As I see it, students must not only actively participate in the culture of science; they must have opportunities to be producers of science and culture—to explore multiple methods of talking, thinking, and doing science.

Interestingly, it is often informal science experiences that young people find fun and relevant to their futures (National Science Foundation [NSF], 1998). Informal science is nonschool- and noncurriculum-based interaction with science in environments such as, science centers, museums, zoos, parks, and nature centers (Crane, 1994; Hofstein, Bybee, & Legro, 1997). These voluntary and self-directed learning experiences, including participating in community youth programs about science, are often the impetus for further exploration into science as a career (NSF). Why are informal science experiences more attractive and relevant to young people than school science? What does informal science add to our understanding of how to create relevant educational experiences in urban settings? One possibility is that in informal science settings adults and children are freer to experiment with science and how to learn it. As Barton (1998a) described, the role of an informal science class "was not simply to help the students 'do science' but rather to do that which grows out of their questions and experiences" (p. 112). Valuing children's experiences "shifts the dynamics of what counts as science and who can do science because children would not have to silence certain experiences or feelings traditionally labeled outside of science" (Barton, 1998a, p. 386).

Here, science teaching is responsive to students' understandings inside and outside science; it reflects a position that learning (and learning science) is a personal and intimate endeavor and that teaching often embodies characteristics outside what is considered scientific. I am reminded of my ninth-grade biology class when I was instructed to dissect a frog. This was an emotional experience for me, situated in a particular personal history, producing a request not to participate that was denied as too subjective, not a part of science. I still refused to engage in the dissection and failed the class. Unfortunately, I came to view science as at odds with whom I was and wanted to be, and I did not enroll in another science course in high school. My teacher's response to my refusal to dissect a frog is only relevant to the production of science learning to the extent the teacher recognized—or in this case, didn't recognize—that experiences typically labeled outside science are not outside science learning. Might it have been possible for my biology teacher to suggest other ways of learning about anatomy that respected my sensitivity to the natural world? What did I learn about myself as a learner of science in the absence of such suggestions?

Supporting children in bringing their interests, experiences, ideas, and emotional responses to science is fundamental if children are to be producers of science. As producers, relevancy is inherent in science learning because the environment for learning science is part of what is created. In a *practicing culture of science learning*, children draw on as well as define science, its activities, and its uses within a particular context for specific purposes. Here I place the emphasis on *practicing culture* to highlight the active means by which students play, muck around, and essentially create science (and sciencelike) performances, tools, and discourses that are extensions of their lives, cultures, and communities. I do not mean to imply that no culture of science practice exists and that students should not be acquainted with it or indeed succeed in it. Rather, I am arguing that part of what is possible in a practicing culture of science learning is that science can be learned even when one's experiences in science are at odds with one's experiences outside science. The emphasis is not on changing what is learned but on how it is learned. By practicing culture, students can give creative expression to the talking, thinking, and doing of science. Multiple perspectives and ways of understanding the world would be the creative mortar for students' constructions in science. From this perspective science education is not only about teaching the ''big ideas'' of science (or helping students construct them). In fact, I view science as not just the particular knowledge achieved but also the very process of discovery, which has given rise to many big ideas. If I were creating (or, more precisely, duplicating) a culture of science practice, then what counts as science and science learning might be left unchallenged. However, if I am practicing culture, then the methods of learning science are informed not just by science or what scientists do but by the many ways of understanding of the world and by the expressions of those understandings—as shown in the following example, the multiple ways of researching and using the material and social resources of a community to imagine and then enact environmental options. In sum, the following are the guiding premises about science and science teaching and learning under which I operate:

- Science is a paradigm that includes a set of practices for describing, explaining, and understanding the physical and social world. Science is not the only paradigm for understanding the world nor is it so fossilized a practice that it cannot include multiple perspectives and understandings.
- Scientific discoveries (the big ideas) are the products of science, not the totality of science.
- It is not *what* students learn, but *how* they learn that is fundamental to a relevant and quality education.

- In a practicing culture of science learning, the production of science (and sciencelike) performances is a creative extension of students' lives, cultures, and communities.

In what follows I will first describe and explain the history of a community-based science project that was coproduced with urban teenagers and my role in the project. Throughout this historical narrative, I will elaborate on my understanding of what it means to create a *practicing culture of science learning* and position this understanding in relation to various discourses of educational relevance. I will draw on research about urban science education and situate my practice within and outside these discourses, concluding with an exploration of these questions: In what ways did an urban planning and community gardening project help to create a learning environment in which science was relevant? To whom was science relevant and toward what ends?

Research Context and Methods

This article is based on a nine-month project that occurred in collaboration with an after-school program operating out of a low-income housing facility. The facility housed up to 200 families and was a temporary residence for homeless families in the process of finding more permanent housing. The after-school program offered various activities such as sports and fitness, ''educational enhancement'' (homework help), and teen services. The science project was targeted to teen services, geared toward youth between the ages of 12 and 16. Although most project participants were teenagers, I did not discourage younger children from participating. In fact, I was supportive of creating multiple zones of development by allowing heterogeneous learning environments to form (Vygotsky, 1978). Over the nine-month period more than 40 children and teenagers were involved in at least one of the project's activities. Twenty of the teens regularly attended the biweekly sessions; however, five moved from the facility before the conclusion of the project. The remaining 15 participants (12 boys and 3 girls), on whose experiences this article is based, were from groups traditionally underrepresented in science.

As a specialist in alternative assessment and evaluation methodologies with a doctoral degree in educational psychology, my role in the project was to create an assessment that provided insights into how students living in urban poverty understand science.[1] I began my work asking critical questions about how an assessment within this context could be created without the assessment itself having an overly strong effect in determining what we did. The goal became to create an alternative assessment tool that emerged simultaneously with the community-based science project. The emergent performance/assessment tool that resulted and how science and science learning were represented have been discussed elsewhere (Fusco, 1999; Fusco & Barton, 2001). In this article I will focus on the process of creating what I call a *practicing culture of science learning,* highlighting what I learned from working with the young people who participated in the project.

My role as a teacher and researcher was grounded in the tenets of action research, which has the explicit agenda of pursuing research for social change (Kemmis & McTaggart, 1988), enriched by critical science education, which seeks to expand Western conceptions of science and science teaching (Barton, 1998; Eisenhart et al., 1996; McShane & Yager, 1996; Rodriguez, 1998), and extended by sociocultural theory, which positions science as an ongoing practice of method (Vygotsky, 1982). Although Kurt Lewin coined the term *action research* in 1940, sociologists such as Jane Addams were conducting local community research directed at action and reform as early as 1895. In action research social scientist and practitioner work together using scientific tools to address local concerns. This action research methodology challenges the Western science tradition of dualistically separating objective and subjective, researcher and researched, rational and emotive, knower and known (see Noffke, 1997, for a review). Knowledge and the ways in which knowledge is produced do not emerge objectively but occur within specific cultural, historical, and sociopolitical contexts. Engaging participants in the production of knowledge toward socially responsible ends is the explicit objective of action research. In this way there are overlaps between the goals of action research and those of critical science education. Both seek to challenge the nature of science and science education, to legitimize the knowledge of and ways of knowing non-Western traditions, and to engage people in science and research as active participants of change. My teaching and research methods were informed by these readings; however, I diverge on one point—the premise that action research, science, and science teaching are fundamentally about the production of knowledge. That is, if, as Hobson (2001) states, "to understand something is to try to change it," then it is human activity (not knowledge) that leads to change. Change occurs not with understanding/knowledge as a prerequisite but as the result. As Vygotsky states it, "Practice belongs to the deepest roots of scientific operation and restructures it from beginning to end. It is practice that poses the task and is the supreme judge of theory . . . (1982, pp. 388–89). For Vygotsky scientific method is not to be applied but to be practiced in the production of cultural and revolutionary activity (Newman & Holzman, 1996). From this perspective, my teaching methods are not separable from my research methods. I was not interested in teaching science knowledge or in researching what students knew in science in the absence of creating a practice in which science and method were produced.

Action research follows a cyclical process of action and reflection. Formal reflection came in two forms: Postmeeting discussions and written evaluations with the young people and my own reflections in the form of field notes. The field notes were written immediately after each meeting or within 24 hrs and took the form of a personalized and detailed account of each session. Statements made by the young people, parents, or staff were included in the field notes; however, because tape-recorders were seldom used, quotes do not represent verbatim statements but reconstructed ones. My field notes were a valuable source of information, filling in the voids inherent in viewing only end products, helping to interpret the data historically, and highlighting the decision-making processes involved in the implementation of the program. In addition, during the course of program activities, various artifacts produced by and with the young people emerged. These artifacts became part of the overall data set and include actual products (letters, notes, flyers, drawings, etc.), visual representations (photographs), direct inquiries (obtained through surveys, written evaluations and reflections, concept maps), an attendance log and summary of activities (or "lesson plans").

The data were examined qualitatively in an ongoing process of generating ideas and forming and answering questions (Erickson, 1986). Themes emerged that became the basis for further analysis and interaction with the data (Bogdan & Biklin, 1992). The questions (In what ways was science relevant? To whom and toward what ends?) emerged when it became apparent through various occurrences that science in this urban context was "real" and was enacted not only for the benefit of the participants but for the broader social implications it had for the community. In the description of the project I present some of the activities that we engaged in over the nine-month period and describe those instances that I interpret as students engaging in relevant science. I believe that in a practicing culture of science learning, science was relevant because (a) it was created from participant's concerns, interests, and experiences inside and outside science, (b) it was an ongoing process of researching and then enacting ideas, and (c) it was situated within the broader community.

A Practicing Culture of Urban Science

Following an action research methodology, it was determined that the initial stage of the project was to decide with the youth what action/practice we wanted to create. The only criterion I had was to create a science/assessment in science that would be relevant to students' lives, used for personal and social purposes, jointly produced with young people, and inclusive of all those who wanted to participate. The goal of the project—to transform an empty lot across the street from the shelter into a usable public space for the community—emerged gradually and began with discussions about the issues and concerns that teenagers face today. The teens spoke about teen pregnancy, AIDS, gangs, drug and alcohol abuse, and violence and produced a collage to express these concerns. The collage hung on the walls of the after-school program for several weeks, with others adding to it. When the collage was complete, I asked the group to come up with a slogan that represented the overall theme. One of the participants held up the cover of an issue of *Times* magazine and said, "That's our message!" The title was "So Young to Kill, So Young to Die." The youth discussed racism, stating that teachers and other adults often have negative perceptions of young people, "especially if you're Black." I explained that I was interested in supporting them in using these experiences and concerns to take action and to engage in action research. For instance, what could we do to inform people about the risk of AIDS, to challenge adults' perceptions of Black youth, or to address urban violence? Could we do anything at all? In the following weeks we began talking about action research and youth development projects. I shared research with them that documented how adult perceptions about youth, homeless people, and women on welfare change as a result of people in the community witnessing these groups engaged in public activities such as community cleanup, mural paintings, and gardening. For instance, one project demonstrated that as adults in the community observed and interacted with youth who taking the leadership and initiative to serve their communities by developing an entrepreneurial garden, they formed new perceptions of inner-city youth as doing "more than looting and rioting" (Feenstra, McGrew, & Campbell, 1999). The teens were interested in these projects and began brainstorming ideas, such as having a bake sale and donating the money to charity. When it became apparent that "we are charity!" the mission of the group became centered on the community in which they temporarily lived. Although I was not sure how science was emerging from these initial conversations and activities, it was important to my methodology that the young people provide leadership in our activities together, that our activities emerge from their interests, experiences, and concerns. I began to think that what we were creating was a human science—a study of our world and ourselves expressed through a variety of artistic forms and oral histories.

Action research engages participants in a collaborative research process that draws on personal experiences and cultural knowledge (Reason, 1988). It stresses that participants do not have to separate themselves from their "study" in order for their work to be scientific. I knew that the lot across the street from the shelter was a possible site for the science project. The director of after-school services informed me of the lot's history as a community garden. Currently, the lot was filled with garbage, drug needles, and other debris and was surrounded by a wire fence that had been knocked down and lay torn and unsafe. As I reflected on the concerns of the youth, it occurred to me that their concerns (drugs, alcohol, urban violence) as well as their action plans (e.g., having a cookout or bake sale to raise money) were embodied in and around this lot. The lot was an optimal site for science and research activities that were grounded in a specific context, rather than an abstract body of knowledge (Resnick, 1987). During our next session I shared with the group how I saw connections between their concerns and a possible plan of action using the lot. I suggested that we go outside to examine this physical space. My field notes capture what next occurred (the names of the teens have been deleted):

> Immediate discussions ensued. [One boy] said that people used to plant some "stuff" there, pointing to the back of the lot, but it was burned down. They also spoke about the fence being knocked down in a "high-speed cop chase." We walked around the lot. A conversation began about how big the lot was. Kids began coming up with strategies for measuring the lot without "exact" measurement tools. [One boy] began counting his steps. Some took guesses; 100 sq ft. [Another boy] pointed to the Green Thumb sign and said, "Here's their number; we can call them and ask." Others counted the number of concrete blocks on the sidewalk that ran from the beginning to the end of the fence.

When I asked them how the space could be used, they constructed an initial list of 16 possibilities including a basketball court, archery range, playground, community garden, jungle gym, stage, cyberspace games, and laser-challenge park. From this list we began to develop a plan to transform the lot into a usable space. Four teams were developed to measure the space, record its living and nonliving contents, take photographs, and sketch drawings of the current state of the space. Each team informed the work of the others. For instance, the observers and recorders documented in writing the "artifacts" that existed in the lot (such as used tires, garbage, drug needles, flower beds, dying bushes); the photographers would capture these artifacts on film, which would later be spatially arranged according to the dimensions of the lot determined by the measurement team. The teams reported their findings to the group and used their newly found knowledge to determine the feasibility of their initial ideas. That is, each of their initial ideas was tested based on their research of the lot. Ideas were relinquished based on the criteria the group had developed (e.g., size, needs of the community, liability, expense). New criteria would also emerge based on the input from various fields of knowledge. At this point, however, several ideas remained plausible given the size and space of the lot, and the discovery of existing flower beds (from the lot's previous history as a community garden). Based on these findings, the list was reduced to seven structural possibilities (all of which could be housed in the space): playground, garden, clubhouse, penny store, jungle gym, sandbox, and stage. The youth then developed conceptual drawings of the space.

I had learned that central to my leadership in the project was the need to have an agenda that was ambitious, required a division of labor, was within a broader objective, and led to products that had a purpose for the group (e.g., measuring the lot was not merely an exercise in mathematics but helped define possibilities). The agenda was always developed in relation to prior sessions and after thinking about what activities might help the group to further develop. Methods, such as recording the contents of the space, were not applied or invoked because of a science curriculum but emerged as activities that would help the group extend its findings and research in the context of developing its plan. I shared the agenda with the group, and they always had the option of not acting on my suggestions, coming up with their own, or doing something completely different. In fact, there were several sessions in which we played basketball or baseball or developed improvisational skits rather than working directly on the design of the lot. I believe that allowing the young people to make these decisions supported their development and the development of the group and its project. This was evident to me on several occasions when youth completed assignments at home and on weekends, exclaiming, "Look! I finished my drawing at home!" or "We worked on our report [over the weekend] and are ready to present."

Developmental psychologists have argued that traditional school environments do not match the developmental needs of early adolescents. At a time when early adolescents need increased opportunities to make decisions and participate in society in valuable ways, teachers spend more time on control and discipline, provide fewer opportunities for decision making and choice, and are less trusting and caring of their students (Eccles et al., 1993). Early adolescents need a means for expressing themselves to the outside world and opportunities to participate in meaningful and collaborative real-world activities (Conrad & Hedin, 1982). However, opportunities to participate in real-world activities (similar to opportunities to participate in "real" science) alone do not guarantee that young people will find school (or science) more relevant or be less alienated from school and society. I would argue that *how* young people are involved in these activities is critical to understanding relevance. As previously stated, one of my criteria for the project was that whatever we did, it had to be jointly produced with young people. Here, allowing young people to participate in making decisions about what we were doing and how we were doing it was an important part of the ongoing discovery of method, of creating a practicing culture of science learning. What I learned was that this did not mean that I relinquished my capacity to provide leadership and direction to the group (after all, I was part of the group). For instance, I remember one session when several members of the group were being disruptive and the rest of us, including myself, became frustrated. I suggested we end the session, to which one participant responded, "See, you're messing things up for us." When I asked them what they thought we should do, they came up with a detailed plan of giving each person fake money that would lost or gained depending on the person's behavior. When someone's "money" was gone, that person could no longer participate in the group. Their plan produced an interesting tension between wanting the group to provide leadership in our activities, including its own governance, and not losing my capacity to provide direction to the group. Viewing myself as part of the group, I expressed my opinion about setting rules that could result in a form of excluding people from the group. I stated that "everyone in the group has strengths, and in excluding people we might lose valuable skills"—to which several responded, "No doubt." I then expressed the one rule that I thought would be important to remember—"Keep the link." We talked about teamwork and played improvisational games to build a collective team environment. Over time members of the group took on increased responsibility for the group. For instance, a boy who typically was described as "joking around too much" on one occasion took notes during a speaker presentation; on another occasion he organized a display table of the group's work during a community event before I had even arrived. As I have come to see it, in a practicing culture of science learning, it is not just science that is produced but the environment for learning (and learning science).

Unlike with the easily discernible steps of the project (i.e., cleaning out the garbage, fixing the surrounding fence), it was critical to have conversations with colleagues, design professionals, and community members at this juncture critical to further our collective performance as urban landscape designers. With other adults eager to hear their plans and ideas, many participants began to realize the project was not "fake." This sentiment was first voiced during a visit to the lot's owner/manager, an older Latina and longtime community activist. Two of the teens (one of whom spoke Spanish) and I made the trip. In my field notes I wrote:

> There was an intimate excitement about our walk to visit Mrs. D. [They] started saying that they didn't think we'd really be doing anything. [One boy] said, "I thought it was going to be a project, like in school, you know, like a fake project." [The other boy] chimed in

> saying, “Yeah, I didn’t think we were actually going to do it until you started talking about picking up the garbage and stuff.”

The youth began to realize that they were not simply researching ideas (talking about science) but enacting them (doing science). In fact, a week later the group decided on a name—REAL, or Realizing Environmental Architecture League (though there was much debate over whether it should be “league” or “leaders”). The acronym would remain, but would it stood for would later change to Restoring Environments and Landscapes.

A second outcome of inviting other adults with various expertise and perspectives to support our vision was the access to a variety of professional discourses and practices it gave the young people. For instance, a conversation with an environmental psychologist led us to consider new questions such as: What design qualities are being considered (e.g., the structural arrangement, the activities offered within the space, access)? This question triggered further thinking and planning. We began to realize that a stage would require seating, a garden would require sunlight, a playground offered activities for children but that we had not considered activities for older people. From engaging in various discourses, new activities emerged, such as visiting other community gardens and a school with a composting facility, writing letters to the second lot’s owner asking for permission to use the space, writing to organizations that might offer supplies or technical assistance, bringing in greening experts to discuss outdoor design and gardening, producing two- and three-dimensional designs, and testing the nutrients of the soil (see Fusco, 1999, for a more detailed description). The youth did not replicate a knowledge base that was given; they used what they learned to create something meaningful and gave creative expression to their understanding. In this community of practice learning was recursive and at times might not be recognizable as science. I can recall one such exchange:

> *Dana:* If you want to have wildflowers and vegetables, then we need to consider what plants need to thrive.
>
> *Participant:* Yeah, and if we have shows on the stage, we need lights.
>
> *Participant*: Yeah, and we could charge admission.

We never did discuss “what plants need to thrive” in that conversation; however, I was confident that when we designed the space and the location of the flower beds, we would come back to this question (and we did). Several months later some of the participants charted the position of sunlight throughout the day and considered how this would change depending on the season. Using that data, they decided where the seedlings should be planted. In this instance science, as traditionally understood, is clearly identified. However, in other interactions, like the one above, I also see science or, more aptly, the practice of the science method. That is, the participants were engaging in a discourse informed by the need to consider multiple factors of the design. If we want x (to plant vegetables, a stage for shows, a budget to keep the project going), then we need y (to understand what plants need to thrive, to have lights for evening shows, to charge admission fees). If I had only looked at and for science content within these dialogues, I think I would have missed valuable opportunities to build with what the young people were giving to the production of science. Instead, this illustration highlights the potential of an urban-planning and gardening project for affecting change at multiple levels of science and science education, including what counts as science and what could be included as science learning. I use a second illustration to make this point.

During a slide show presentation of outdoor spaces and gardens, we saw structures that had not been considered, such as storage space, a path large enough for wheelchair access, and signs. After watching the slide show, one boy wrote that having storage was important because "we need a place for our tools"; in the construction of the model (several months later), he designed a storage space underneath the steps to the stage. To another participant signs were important "to tell people not to litter." In the model she made a sign that read "Help keep our REAL garden clean!" The young people drew on the knowledge of others, their own interests, and the history of the group to decide on a final design. The final design included a stage for cultural events, vegetable and flower beds for planting and growing, a birdbath and pond for attracting wildlife, garbage cans and compost bins for environmental cleanliness and recycling, signs, picnic tables for eating, chess tables for the "older people," and a garden path large enough for wheelchairs.

Do such changes count as science? In science classrooms that seek to engage students in the work of actual scientists, the goal is "to move from the initial diversity of ideas existing in a classroom to a view that represents a consensus by virtue of its scientific plausibility" (Gitomer & Duschl, 1995, p. 20). Here I return to what I view as the main difference between the culture of science practice and practicing a culture of science learning. That is, in the culture of science practice, scientific plausibility is based on existing laws of science. Do things work the way they are expected to work? Students' understandings in science are judged in relation to a long-standing discourse of science practice. In some cases traditional science knowledge was evident and could be clearly identified as science (e.g., the heavy clay-based soil in the lot meant that most planting would occur within the boxes constructed for that purpose). As shown in Table 1, performance standards for middle school science include connections between science and society, scientific thinking, the use of scientific tools and technologies, and scientific communication. Over the period of the project, the young people engaged in many activities consistent with these performance standards for middle school science (New Standards, 1997). The science of REAL included the processes and methods by which the young people questioned urban violence, brainstormed ideas for bettering their community, and tested the feasibility of their ideas. Science was also enacted in researching the lot—its physical (size, soil quality, living and nonliving characteristics) and social elements (history as a garden, current contents that reflected political and economic conditions). Research was conducted using observations, recording tools, historical living records, various forms of analyses, and through engaging in substantive dialogues with professionals with different expertise. They utilized various tools (e.g., blueprints, rulers, linguistic discourses, technology, and media equipment) to facilitate their work. Results were communicated through art, narratives (written and oral), photography, reports, videos, and 3-D models.

However, in a practicing culture of science learning, plausibility must also be understood within the history of the particular group of participants. The decision to create a storage space underneath the steps to the stage was plausible because it was strategic and based on many factors that emerged from months of research (e.g., the need for storing gardening equipment and supplies, the need to secure equipment and supplies, the amount of space available in relation to the overall design). The decision to include signs was also strategic and emerged from months of research (e.g., the prevalence of garbage in the lot, the absence of garbage cans on corners). Further, these decisions demonstrate how participants used their creativity and resourcefulness to enact ideas in science and how such resourcefulness interacted and emerged from the lived experiences of the participants. Storage for gardening equipment might typically be housed in a prepurchased toolshed. Signs not to litter might be less prevalent in suburban communities with regular and abundant garbage pickup. As such, the particular decisions that are made in the enactment of science must be understood in relation to the sociopolitical and

Table 1
Middle School Science Standards and their connection to community gardening

New Standards	Evidence Shown by	Community Gardening
Science Connections The student demonstrates understanding of: • personal and environmental safety • the interactions between science and society	• Development of a plan to modify the school's fire warning system for students with disabilities.	• Development of a plan to modify an empty lot into a usable and public space for the community that includes considering access for people with disabilities.
Scientific Thinking The student demonstrates scientific inquiry and problem solving by using thoughtful questions and reasoning strategies.	• Evaluation of the claims and potential risks and benefits of a newly advertised diet pill.	• Evaluation of the characteristics of the physical space to determine the viability of ideas, considering the risks and benefits to the public.
Scientific Tools and Technologies The student demonstrates competence with the tools and technologies of science by using them to collect data, make observations, analyze results and accomplish tasks effectively.	• Use of technology and tools to observe and measure objects, organisms, etc., by conducting a field research project.	• Use of technology and tools to observe and measure the living and nonliving things in the lot, to design flyers for advertising Community Day, to assess the community's responses to the garden.
Scientific Communication The student demonstrates effective scientific communication such as representing data in multiple ways.	• Making an animated video illustrating how white blood cells protect the body from infectious agents.	• Making of a video illustrating how community gardening protects/benefits people socially and psychologically.

cultural context within which science is occurring. This was not science as found in a textbook; there was no one base of science knowledge that could be applied to the production of the lot. It was a science in creation and within the context of a broader community. Then, plausibility must also be "tested" within the broader community. The local community in which science was located and had a purpose would judge the plausibility of the group's research, ideas, and design.

Community Day was both a culminating event of months of research and the initial step in putting their plan into action. To publicize the event, the teens drafted a flyer on the computer that was distributed to families, staff, local storeowners, and neighbors. Community Day brought out approximately 50 parents, staff, volunteers, neighbors and children. A three-dimensional design model produced by the teens was displayed, and the young people shared their plan with passersby and family members. Members of REAL had various roles and responsibilities for the day, such as welcoming guests, managing the overall production, organizing the refreshments, and video-interviewing participants. Some helped to clear out the garbage and sort recyclable from regular garbage. With the assistance of a professional carpenter, some dug holes for fence posts and cut the wood to the proper size, creating sturdy structures for a new fence. A group of young people from the neighborhood exclaimed, "We made a pond from natural resources!" The trees and existing flowers were watered. Signs were painted with the message "Help keep our REAL garden clean!'' Seeds and seedlings were planted with the assistance of one of a shelter resident who was an expert gardener from Trinidad.

Several youth video-interviewed volunteers, asking them questions including: ''How do you think the garden will help the community?'' The question itself, which was designed by the ''media team,'' reflects how the participants framed science as a humanistic endeavor. The responses, ranging from the personal to the political, also exemplify how the doing of science was beneficial to the local community (see also, Barton & Darkside, 2000):

> It's gonna give us [a] sense of responsibility because we're transforming something. We're making something out of nothing. We're gonna be extra proud because we did it. (After-school coordinator)

> It's gonna turn out to be beautiful. It's gonna help the children take care of the neighborhood by seeing beauty. (Parent volunteer)

> It will help the community by giving kids a place to come. Instead of being out in the street and doing things they shouldn't be doing, they can come in here and just relax and enjoy themselves. (Teen participant)

> Because we need to [do] something for these kids right now. Things are not going good right now. Because you know how New York is filled with violence? So an event like this right here, it helps get away from all the violence. (Teen participant)

Was Science Relevant? To Whom and Toward What Ends?

I believe that science was relevant to the participants as interpreted through such instances as the completion of tasks at home and on weekends, increased participant level of responsibilities within the project, the view of the project as not ''fake,'' the self-defined name of the group (REAL), the participant capacity to use the history of the group, and the totality of what was learned toward their productions in science (e.g., building storage into the 3-D design model). In addition, participants could articulate in rich detail the goals and activities of the project in conversations with others, in letters to organizations, and in interviews. As Darkside states,

> Like in the abandoned lot action research project, we were doing science. We were using our hands, our minds, figuring out what we need here, what we need there to make the garden. It's like, we start with the lot, and we have to decide what are we going to do with it? It is full of litter and pollution. It has got needles, trash, and all of that nasty stuff. Then, we talk about, debate it, and decide what to do. What we did was some research on what we *could* do. What was cheap? What would not have too much upkeep? What would other kids not vandalize? We measured the lot, using math and measuring tapes. Then we made maps and 3-D models of what we wanted to do. In the end, we decided on a community garden. That's doing science. (Barton & Darkside, 2000, p. 34)

Not only was science relevant to the participants as they enacted a vision for local change, it also helped to create a vibrancy and energy within the after-school program and within the local community. The staff of the after-school program began describing REAL as one of the main after-school activities (in addition to homework help and recreational activities). They spoke about REAL to board members and funders and asked me to present the project at a board meeting. Several parents were excited to participate and ''lend a hand''; about 10–15 of them participated during Community Day. Two mothers, in particular, were amazed that their sons were ‘‘doing well’’ in REAL. One mother showed me her son’s report card (mostly Cs and Ds) and asked me, ‘‘What do you do with him?’’ She was curious because her 15-year-old son never did homework for school, yet he voluntarily worked on at home and on weekends doing such activities for the project as signing up volunteers for a Community Day or working on the computer to draft a flyer. Members of the local community were also affected. Adults and children from the neighborhood and residents of the shelter interacted and shared resources toward a common goal. An older man who lived in the apartment building next to the lot told me he had been keeping the garden clean by disposing of displaced garbage. He also bought colored pebbles that he laid around the base of several young trees that were planted. A local youth told me that a week after our first Community Day, a group several blocks away decided to reinitiate their community garden that had been lying dormant for several years.

I have come to see that in this *practicing culture of science learning,* science was relevant because it (a) was created from participants’ concerns, interests, and experiences in and outside science, (b) was an ongoing process of researching and then enacting ideas, and (c) was situated within the broader community. In the practice of REAL research began with the concerns of today’s urban teens and led to a plan for action, the enactment of ideas, the sharing of knowledge with various experts, and the involvement of the local community. Activities had a purpose that were embedded in a broader objective. Ideas were tested through traditional modes of scientific processes, as well as within and by the broader community. This involvement and support of the community affected the youth in ways that extended beyond the learning of science knowledge and skills. As one participant expressed, ‘‘I really like doing community projects—it gives me a sense of responsibility and gives me a good feeling about helping people in the community.’’ Another member of REAL felt that fixing up the lot gave people ‘‘things to do’’ and helped ‘‘get away from all the violence.’’ REAL was born to directly address the concerns of young people, including gangs and violence. As evident in various statements made by the youth, such as ‘‘You down with REAL?’’ and ‘‘I’m getting REAL painted on the back of my denim jacket,’’ the project members over time formed their own ‘‘gang,’’ with its own name, logo, and message. The result was not only the individual learning of science knowledge but the creation of science (and sciencelike) discourses, tools, and practices that had a real purpose within people’s everyday lives. This perspective necessitated an understanding of learning that went beyond a strictly cognitive interpretation. As Lemke recently articulated, ‘‘An apparent assumption of conceptual change perspectives in science education is that people can simply change their views on one topic or in one scientific domain, without the need to change anything else about their lives or their identities’’ (2001, p. 301). What this suggests to me is that as youth, science, and community interact, the potential for change occurs at many levels—within the person, within the physical and social environment, and within the culture of science and science education (Table 2). These changes occur as a nexus of interrelated and situated shifts in learning and development rather than as mentally isolated changes in knowledge. Changes within the participants’ ways of talking, thinking, and doing science occurred alongside practice and the creation of a science in which they would help minimize violence, beautify the community, and foster social and community gatherings and interactions. Changes in how participants viewed the doing of science were supported by a vision of science education that did not adhere to a strict curriculum or follow one pedagogical method but was created in a reflexive relationship with youth and used for the purpose of local action. Young people were the producers, rather than users, of science. Using the available land (an empty lot) and natural resources, we could engage in science in the context of urban life and community. We could use science as one of the means to produce change. Situating science in daily community life offered an optimal site for

Table 2
Levels of potential change in the interface between youth, community, and science

Change at a personal level
- Young people become active agents of change as they investigate their environments and develop action plans.
- Developmental needs of young people, such as making important decisions, taking on new roles and responsibilities, forming caring relationships with peers and adults are met through increased responsibilities in planning-for-purpose (Eccles et al., 1993).
- Participants learn the interconnectedness of science, math, and technology, as well as scientific methods and processes.
- Participants achieve graduation standards, such as community interaction, SCANS skills, and team building (Lawson & McNally, 1995).
- Participants have the opportunity to interact with adults from a variety of professions and learn about new career possibilities.
- Participants have the opportunity to be successful and feel proud of their accomplishments.

Change in the environment—physical and social
- Leads to changes in the landscape—community development and beautification.
- Gardens offer places where people meet and interact and sustains community life.
- Change mushrooms; others who witness youth involved in various acts are motivated to do the same.
- Perceptions about youth, homeless people, and women on welfare have changed as a result of witnessing these groups collectively engaged in productive activity (Feenstra, et al., 1999).

Change in the culture of science and science education
- Action research models afford a model of science action toward local change and reform.
- Science is less bound to traditional inquiries and methods.
- What counts as science (and science learning) expands to include what is created through multiple forms of human expression.
- Gardening allows one to recognize the importance of ecosystems and the interdependency of life, in addition to the contemporary school view that society requires technological innovations based on rational models of science to advance (Kiefer & Kemple, 1998).
- Gardening changes "the ways children learn in school, ways that are more ecologically based, inquiry driven, community-centered, and collaborative" (Kiefer & Kemple, 1998, p. 101).
- Youth are users and producers of science; they are tool users and-makers inside and outside science.

expanding the boundaries of science. However, this gives science itself a different look and feel than that of school science. For instance, when planting seedlings, a 9-year-old girl asked, "How deep should I dig the hole?" To which our local expert gardener responded, "About this deep [pointing to the length of his index finger]". As Rahm (1999) wrote, "Expert gardeners know how to translate "exact" planting information into practice in a way that is meaningful and practical (i.e., using a finger to determine planting depth)" (p. 9). Rahm demonstrated that people learn science in a variety of ways, for a variety of purposes, and from a variety of sources. Here the enactment of science included access to practical science knowledge and the opportunity to engage in science and action research that served a purpose within the community.

Science was supported by a non-Western vision; it was socially oriented rather than task oriented (McShane & Yager, 1996). From feminist and multicultural perspectives we are urged to use the strengths of urban diversity and compassion for local action and change. Through this lens we recognize that while a constructivist approach to teaching and learning more accurately portrays how science knowledge is produced, it ignores the sociopolitical factors that have created the educational environment that many young people opt out of (Fine, 1991; Nieto, 1994). Rodriguez (1998) critiqued cognitive and constructive psychology on the basis that it omits "the complex socioeconomic and cultural complexity of schools by not acknowledging that not all children may be willing to learn the prescribed Western ethnocentric curriculum; and that not all children (apprentices) may be able to trust the teachers (masters)'' (p. 596). Eisenhart et al. made a similar argument: ''Opportunities to practice 'real science' . . . are not likely (alone) to increase the chances that students will want or be able to use academic science in their lives beyond the school'' (1996, p. 271). Seen from this perspective, educational reform can be transformative only to the extent it creates an inclusive system where culturally relevant world knowledge and ways of knowing are reflected in what is to be known and evidenced. If science is to be relevant to all learners, it must respond to and emerge from the life experiences, questions, and interests of all learners (Atwater, 1996; Barton, 1998b; McShane & Yager, 1996; Rodriguez, 1998). An implication of this perspective for science education is that students should gain ''a sense of science as something that is important in their lives and their community outside of school'' (Eisenhart et al., 1996).

I think critical to this vision was that the young people were at the center of this interaction. They were givers and creators of a plan to improve the community (physically and socially). This process required space for the young people to brainstorm and plan and space for me to reflect on the ideas and methods that were emerging. It required the radical acceptance of their interests and choices, even when such choices meant we did not work directly on the project. It also required that although I sometimes might pose recommendations, the young people also posed their own. I believe that this was possible because we could engage in ongoing action and research. We could try out new methods (methods of teaching and methods of doing science) and reflect on how well they worked or did not work. We were involved in an ongoing process of discovering what was required to create a collaborative learning environment that supported the young people to enact their performances as scientists, journalists, urban landscape designers, and so forth. As Holzman describes it, ''Practicing method is an explicitly participatory activity that entails the continuous, self-conscious deconstruction of the hierarchical arrangements of learning, teaching, and knowing'' (1997, p. 11). Although I did not always know how science would emerge or where we would end up, the lot offered a site within the community to create a practicing culture of science learning. What became important was not the content imbedded in domains of knowledge but the opportunity for young people to perform as urban planners, designers, researchers, activists, scientists, mathematicians, photographers, journalists, and so on. Science was not an abstract body of knowledge to be learned but was ''something to be proud of, to be remembered by, and to help beautify the community,'' as one youth put it.

What do young people mean when they say school is boring or not related to their lives or their futures? I do not think they mean that the knowledge or content is useless but that the context for learning it does not support their development. Textbook assignments and worksheets are perceived as methods of ''dumbing down'' (Barton & Darkside, 2000; Nieto, 1994). Situating science content in classroom-based projects might offer a more embodied experience of the field of knowledge; however, as one participant in REAL expressed, these school projects are perceived as ''fake.'' They have no purpose connected to serving others. What I have learned from the practice of REAL and from the participants and community members involved in the project is that school learning should offer opportunities for students to be givers. One possibility is to help students research and then enact ideas that serve a purpose for their friends, their families, those in the classroom community, those in the school building, or beyond. Events such as science fairs extend the audience for student enactment in science and often trigger enthusiasm as students realize that their work will be noticed and perhaps useful to others. What is of value here is not only the *what* of science but the *how* of science learning. In an environment in which students are givers, they also help to create the environment for learning science. Not all students learn in the same ways, and not all students will be interested or disinterested in the same things for the same reasons. As teachers, if we can connect to all that students are inside and outside science, including students in the creation of the environment for learning science, and if we can connect science to broader social objectives, then students might also learn that they are learners and users and makers of science and sciencelike practices.

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