

Micros and Me: Leveraging home and community practices in formal science instruction

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Abstract: Critiques of school science from sociocultural perspectives focus on the narrow scope of the science that is presented to students in school, which in turn constrains how children should engage in scientific sense-making in classrooms. We have designed a seven-week instructional intervention, *Micros and Me*, which attempts to (a) make science more personally consequential to students' lives and cultural memberships, and (b) connect authentic scientific practices deeply with students' repertoires of practice. We report on two iterations of *Micros and Me*, focusing our analysis on two design issues: (1) how we attempted to broaden the definition of what counts as school science through a self-documentation task, and (2) how the self-documentation task problematized the conception of "culture" in each of the classrooms. We end with design implications for the design of science learning environments that take as their starting point deep knowledge of students' repertoires of practice.

Introduction

Research suggests that wanting to participate in science is influenced partly by whether students identify themselves as people who can or cannot do science (Brickhouse, Lowery, & Shultz, 2000), yet unfortunately science as it is traditionally taught in schools has little to do with the science done by scientists or science as it is practiced in children's everyday lives. In traditional school science, there is usually one "right" answer, and one "right" process to find that answer. Uncertainty and controversy are not part of the discourse of school science textbooks, and laboratory exercises in which students attempt to approximate the "right" answer leave little room for discussion and debate (Bell, 2004a, 2004b).

Critiques of school science from sociocultural perspectives focus on the narrow scope of the science that is presented to students (Warren, Ogonowski, & Pothier, 2003; Eisenhart, Finkel, & Marion, 1996), which constrains how children should engage in scientific sense-making in classrooms (Ballenger & Carpenter, 2004). School science is overwhelmingly Western science (Harding, 1998), with a narrow range of norms of practice (Aikenhead, 1996; McIntyre, Rosebery, & Gonzalez, 2001). Furthermore, these norms of practice may not necessarily be consistent with students' cultural ways of knowing. The literature from sociocultural perspectives tells us that there are problematic ways in which science instruction (and school instruction in general) has attempted to leverage students' repertoires of practice. One way is essentializing students according to their presumed membership to certain cultural groups (Nasir, Rosebery, Warren, & Lee, 2007). Cultural essentialization leads to "treating cultural differences as traits" (Gutierrez & Rogoff, 2003, p.19), unchanging over historical time and belonging to every member of a cultural group. One danger in seeing cultural differences as traits instead of dynamic processes that vary between individuals is the tendency to see these traits as explanations for underachievement, behavior, or other academic problems that apply to all members of a cultural group—the deficit model of cultural differences. Instead, Gutierrez & Rogoff argue that we need to see individual students as having their own experiences and histories that are influenced rather than dictated by their membership in certain cultural groups.

Another, related way in which culture is treated problematically in classrooms is making superficial connections between specific cultural practices (often assumed to be practiced by *all* members of a particular cultural group) and classroom learning. Warren, Ogonowski, and Pothier (2003) cite the example of cooking rice and beans as a way of demonstrating phase transitions. While it is fine to bring such examples in the classroom, we need ways to connect students' culturally-based ways of knowing deeply to scientific meaning making in classrooms. Cultural practices need to be constructed as rich sites of complex reasoning that can be applied to discipline-specific reasoning practices in classrooms.

These critiques underlie the importance of expanding what normally "counts" as science to include children's everyday expertise, or what Gutierrez and Rogoff (2003) call "repertoires of practice". Repertoires of practice refer to the dynamic ways in which people engage in activities based on their background experiences, interests, and cultural memberships. Rather than assuming that certain instructional contexts will connect with students' lives and therefore be motivating contexts for learning, we take the perspective that others (Lee, 2007; Warren, et al, 2001; Moll, 2004) have taken that the design of instruction should begin with deep knowledge of

students' repertoires of practice and their corresponding areas of expertise and connecting that in meaningful ways to authentic scientific practices. To this end, we have designed a seven-week instructional intervention, *Micros and Me* (Tzou, Bricker, & Bell, 2007), that attempts to (a) make science more personally consequential to students' lives and cultural memberships, and (b) connect authentic scientific practices deeply with students' repertoires of practice. In this unit, we attempted to elicit and leverage students' repertoires of practice around health in order to motivate the study of microbiology and the connection between microbiology and health. We assume that part of what goes in to building a student's repertoires of practice around health is their membership in certain cultural, family, community, or peer groups.

In this paper, we will describe the context for the science instruction at the study site, briefly describe the design of *Micros and Me*, and present findings from analysis of two iterations of the curriculum, specifically around a self-documentation task (Clark-Ibañez, 2004) in which students were asked to document their health practices and connect those practices to a scientific research project. We end with dilemmas and design implications for applying leveraging students' repertoires of practice in the design of discipline-specific science learning.

Research Questions

In this design, we asked three questions: (1) how can we *elicit and make visible* students' everyday expertise around health in science instruction? (2) how can we *deeply connect* this expertise to disciplinary practices in science? (3) what are implications for design of science learning environments that start with deep knowledge of students' repertoires of practice and connect disciplinary practices to that knowledge?

Context for science instruction at Granite Elementary

We conducted this design work in collaboration with three fifth-grade teachers at Granite Elementary, a school located in the southern part of a large, urban city in the Pacific Northwest. The school is marked with significant ethnic and linguistic diversity, with a significant percentage of students on free and reduced lunch, and high achievement on the state standardized tests. This design collaboration is part of an ongoing (5+ year) partnership with the fifth grade teachers at Granite Elementary.

Design of Micros and Me: an overview

This work is tightly connected to a cross-setting team ethnography of thirteen children's activities in and out of school in order to analyze several conceptual themes: personally consequential biology, argumentation, images of science, diversity (cultural, gender, economic) and uses of technology (cf, Bricker & Bell, 2008). The team has followed the children and their families in school, at their homes, and to a wide range of settings in order to understand the everyday sensemaking practices of children across the settings of their lives. Of the thirteen focal participants in the ethnography, four children were in the fifth grade classes in which the designed curriculum was first enacted. The major goal in the design was to understand how to better architect learning pathways between home and school through:

1. meaningfully incorporating ethnographic findings and protocols into the design of the unit, and
2. eliciting and deeply incorporating students' areas of everyday expertise into the science instruction using ethnographic methods.

Micros and Me is a re-design of an existing commercially-available kit called *Microworlds* (NSRC, 2002). The elementary science program in the school district to which Granite belongs is composed entirely of commercially-based kits. Every year, three such kits are taught, and *Microworlds* is one of the three kits taught in fifth grade in the district. The decision to re-design *Microworlds* as opposed to one of the other units in the fifth grade science curriculum was the prevalence in the ethnographic data of chronic health problems such as asthma and allergies. Granite Elementary, and many of the students who attend Granite, live in an area of Seattle that has a very high incidence of hospitalization due to asthma—many times higher than the rest of the county. The area of the city in which Granite is located—Granite Hills—is very industrialized, near ports, railroad tracks, and an airport—all of which are major contributors of pollution. Therefore, we chose to re-work *Microworlds* to help students see the connection between consequential health decisions and practices and scientific inquiry.

Methods and data

We situate this work under the umbrella of *design-based research* (Collins, 1992, Bell, 2004a), in that we are attempting to understand how to design a personally consequential science curriculum that highlights children's everyday cognition at the same time that it engages children in systematic, discipline-specific practices. The

literature is thin on work that designs for students about whom we have thick descriptions from their everyday lives. Seldom do designers have firsthand insight into lives of the children for whom they are designing.

Micros and Me was enacted for the first time in the spring of 2007 and every year since in all three fifth grade classrooms at Granite Elementary. A variety of data sources were collected during this effort: daily, videotaped observations of every day of the enactment, artifacts the students produced (including science notebooks, final reports and projects, pre/post assessments, and surveys of their everyday activities), and interviews with focus groups of students after the enactment. For the purposes of this paper, we draw on videotaped observations of students and teachers during the self-documentation lessons and the pictures and journals from 34 students across the three fifth grade classrooms. Videotaped observations were content logged and key episodes were transcribed in more detail.

Journals and classroom talk were analyzed for evidence of repeated activity systems that pertained to health and explanations for those activity systems that were rooted in family or cultural belief systems. We were especially interested in understanding whether the self-documentation technique would give us enough insight into students' everyday expertise around health that we could connect that expertise to the classroom scientific inquiry. Therefore, the following analysis is not so much concerned with the particulars of what students took pictures of, but of the potential for eliciting and making visible students' health practices in the context of classroom instruction. We use as a theoretical basis for this analysis the Everyday Expertise framework (Bell, et al, 2006), that highlights three dimensions of analysis: individual, social, and cultural, as well as the accompanying learning phenomena for each. *Cognitive ecology* refers to the diverse terrain of influences on the way an individual cognitively makes sense of, or assigns meaning to, the world. For example, an individual may have certain ideas about herself as a learner (epistemological knowledge) based on cultural, gender, age, and class identities, and these ideas influence the way she acts upon the world (diSessa [2002] for his notion of conceptual ecology). Although these histories and experiences are socially situated, they are considered here in relation to how they influence the perceptions and actions of individuals as they engage in social activity.

Situated activity systems refer to activity that takes place within the boundaries of a (socially constructed) place (Goffman, 1961). Individuals can "boundary cross" (Phelan, Davidson, & Cao, 1991, p. 227) as they move between activity systems, each of which contains culturally-based narratives. The social plane is the space where individuals enact their personal epistemologies in social interactions and in situated activity systems. As individuals enter places, they interact not only with each other but also with the cultural narratives and resources available in those places. Cultural toolkits (Swidler, 1986) refer to the ideologies, technologies, and narratives that are uniquely present at a given historical moment. We consider cultural activities and toolkits broadly, to include resources from environmental education, environmentalism, school, ethnic group memberships, and religious participation. These toolkits then shape activities and interact with an individual's own cognitive ecology.

Taken together, these dimensions help us see the practices that students self-document and discuss in class as situated within activity systems in specific socio-historical contexts. For example, when students self-documented a narrow range of health practices relative to the variation that we knew existed based on our ethnographic work, this framework allows us to interpret those findings in light of norms within the situated activity system of "doing school science" that typically allow for only Western science practices to count as school science (Harding, 1998).

Findings and design implications

In this section we present findings from an initial analysis of the self-documentation task and design implications from those findings for the next design iteration of *Micros and Me*. We present our findings by telling the design story of the curriculum over the first two iterations, which occurred in the spring of 2007 and the spring of 2008.

Iteration 1: Making visible students' everyday expertise around health through self-documentation

We knew, from our ethnographic findings, that students in this school population engaged in rich and varied repertoires of practice around health. Reeve (in preparation), using Chrisman & Kleinman's (1983) framework of multiple domains of health care, reported that families in the ethnographic study utilized multiple domains (what Chrisman & Kleinman call professional, popular, and folk) to manage their health care. This means that they went outside of established Western medicine in the maintenance and treatment of health-related issues. In this population of students, therefore, we were expecting to see similar varieties of health-related practices. Our first attempt to elicit and make visible students' everyday expertise around health was through student self-documentation. This was a photo-elicitation activity (Clark-Ibañez, 2004) in which students took pictures of practices they engaged in around health and explained how those pictures related to health. We loaned each student a digital camera for one night and

asked them to take pictures of activities that they engaged in around health. We also gave students a worksheet to document and explain the pictures they took. The intention was to gain a deeper understanding of students' repertoires of practice around health in order to connect those practices with the scientific inquiry in the classroom. We hoped that one of the activities documented during the task would be used as the basis for students' research projects at the end of the unit.

After we collected their pictures and their worksheets, we constructed what we called "maps" of their everyday health expertise using a commercially-available comic-strip making software program. These maps showed a subset of the pictures each student took (chosen by the researchers as the practices that had the most potential to be research topics) and the explanations of those practices in the students' own words.

Construction of self-documentation activity as "school science" activity

In the first iteration of *Micros and Me*, there was wide variation in what the students documented as related to staying healthy and preventing illness. However, most of these fell squarely into what we would categorize as "mainstream" practices, well-documented in Western science as linked to health maintenance (drinking water, handwashing, eating vitamins, etc). We were at first disappointed in these results, since from the ethnographic data we had conjectured that this population of youth would engage in more varied practices around health. However, we soon realized that the self-documentation task was capturing only a partial list of health practices in which students engaged. When teachers conducted discussions with students about their self-documented pictures, we found that the classroom discussions showed potential to be rich sites for further exploring students' repertoires of practice around health. Consider the following brief discussion in one teacher's classroom:

- 1 Ms. E: One thing I'm always wondering about I think would be my topic is in my culture, in my family, everybody says I'll make you chicken soup, it'll make you feel good. And I always wonder is that just something to make people feel good because it's nice and warm and shows that people care about them, or is there something in the chicken soup that helps you get healthy. So that's a cultural thing that I always wonder about that has to do with being healthy. I want you also to think about tonight is there anything in your culture that has to do with um staying healthy or that people say. Some cultures have special things they wear, or put on their bodies to prevent them from getting sick or help them get healthy. Robbie
- 2 Robbie: You get a coin, and get this white or green ointment and put it on your back.
- 3 Ms. E: but is to help you get better or prevent you from getting sick?
- 4 Robbie: better
- 5 Ms. E: Ok so that's another cultural thing. Danielle
- 6 Danielle: there's this dance that you do
- 7 Ms. E: Ok so a dance. And is it supposed to help you get well?
- 8 Danielle: Yeah
- 9 Ms. E: Ok. So there's lots of things that we do in our culture, ethnicities that have to do with getting well. And I still have to find out if they always say I'll make you chicken soup is it going to help you feel better or is there something inside. So tonight as you're thinking about this, I want you to start thinking is there something in your pictures that you would like to research about staying healthy. (*Transcript of Classroom observation, 2007-05-29*)

In the above example, Ms. E was able to elicit culturally-based health practices that had not been documented in Robbie or Danielle's self-documentation tasks. By modeling the cultural practice of making chicken soup, she helps students understand what "cultural practice" means in this context. This is evidenced by Robbie's and Danielle's responses. However, she also says, "I always wonder is that just something to make people feel good because it's nice and warm and shows that people care about them, or is there something in the chicken soup that helps you get healthy", thus indicating a way in which a cultural practice could be leveraged in the context of a scientific research project. She not only asks questions that would allow her to examine that cultural practice scientifically, but also indicates ways in which it could be connected specifically to microbiology and health.

The contrast between the practices documented in the self-documentation activity and the practices students shared during the class discussion are evidence that the students were constructing this activity as a "school science" activity—where a narrow range of practices usually "counts" as science. When the teachers explicitly inquired into practices that were *cultural*, a different range of practices emerged. In the second iteration, we decided to more explicitly address "cultural practices" in the self-documentation task, building in more formal structures to do so.

Iteration 2--Explicit conversations around cultural practices: problematizing "culture" and the Costco incident

In the next iteration of *Micros and Me*, we had the teachers make two substantial changes to the self-documentation task. First, they presented their *own* self-documentation maps when they introduced the activity, giving students a chance to see their teachers' repertoires of practice around health. We hoped this would prompt the students to think about the self-documentation task more broadly, outside of the narrow confines of Western school science. The second change was instituting a whole-class discussion in which teachers specifically addressed practices as "cultural", in order to get a better idea of what Gutierrez & Rogoff (2003) call the "historied and varied practices" that students engage in around health. What emerged was both a broadening of "what counts" as science and a problematizing of what it means to talk about practices as "cultural".

The whole-class discussion around cultural practices was preceded by a discussion in which teachers simply prompted students to share some of the practices that they had documented. In this discussion, the practices that students chose to share all fell squarely within the confines of Western science: eating off of clean dishes, using Clorox, drinking milk, washing hands, taking vitamins. In the *next* discussion, however, when the teachers addressed practices explicitly as *cultural*, a very different list of practices emerged (see Table 2). We argue that Discussion 2 was able to somehow elicit a qualitatively different list of practices, most of which were documented on the self-documentation maps, but not shared in Discussion 1. Many school science activities would have stopped at Discussion 1, but would have missed the rich variation in practices that were elicited in Discussion 2. Because the space was opened up in Discussion 2 to accept a broader range of acceptable practices in the context of science class, students re-constructed the task as something different from a school science task (as illustrated in the difference between the two lists).

Table 2: Comparison of elicited practices in Discussions 1 and 2 in the second iteration of *Micros and Me*

Discussion 1	Discussion 2
<ul style="list-style-type: none"> • Eating off of clean dishes • Taking showers • Brushing teeth • Drinking milk • Using a vacuum • Washing hands • Taking vitamins • Drinking water • Exercise • Using Clorox 	<ul style="list-style-type: none"> • Mangosteen for allergies • Pho: prevents illness • Tea (black, cinnamon, brown) • Green oil on back, scratching with a spoon: tells you how sick you are and helps you get better • Ginseng: clear face, helps make you feel better

In the following example, we show a short excerpt from the beginning of Discussion 2 in Ms. Evans's class to examine the pedagogical moves made during this discussion.

- 1 Ms. E: Allison and Kristin, because you both know it. How many others of you know what Mangosteen is?
- 2 Student: Can you show us an example?
- 3 Ms. E: I don't have one, I've never seen it, I know nothing about it. Can you t--So yes, I can. Ok? (holds up a
- 4 student's self-doc with it)
- 5 Ms. E: This is mangosteen. Tell us what you do with it.
- 6 Allison: um, when you buy it I put it in a tablespoon and then I drink it.
- 7 Ms. E: and so what does m--what does mangosteen--why do you drink it? Does it taste good?
- 8 Alice: It gives you energy and then it keeps you from sneezing and allergies.
- 9 Ms. E: And so you just take one spoon and it, and it keeps you...
- 10 Alice: from sneezing and allergies.
- 11 T: Ok, so it keeps you from sneezing and allergies.
- 12 Ms. E: Amy, you say you use it as well? Do you use it for the same thing?
- 13 Amy: yeah
- 14 T: And do you take it when you're sick or do you take it to prevent sickness?
- 15 Amy: Every day
- 16 Ms. E: So you think it would prevent this.
- 17 Ms. E: Do you use it as well? Do you use it for the same thing?
- 18 Ms. E: Anybody else use Mangosteen?
- 19 Ms. E: So if you look at the jar, and if we look at the jar (gets a student's self-doc), I look at the jar and I've
- 20 never had Mangosteen, or used it, um, is this something that you think is part of your culture?

- 21 Allison: No, you can just buy it at Costco.
 22 Ms. E: You can buy it at Costco. I'm guessing that it's something that your parents or grandparents knew about
 23 because as I look around the room, many of us from your culture don't know about it but all the people that do
 24 know about it are of the Asian cultures. Does that make sense? And so will all who use it go home and talk to
 25 your parents and find out how they knew to use Mangosteen.

In this example, Ms. E makes some pedagogical moves to scaffold the discussion around cultural practices. The first move is a *positioning* move (Harre, et al, 1999) in which Ms. E positions herself, in lines 4 and 21, as someone who knows nothing about the cultural practice in question, drinking Mangosteen. Simultaneously, she positions the two students who documented this practice, Allison and Amy, as experts in this practice, thereby highlighting the value of varied repertoires of practice and in this discussion. Another move Ms. E makes in this discussion is to not assume that all students who might use this product would use it for the same purpose. She asks, in lines 13 and 20, “do you use it for the same thing?”, thereby avoiding essentializing the practice to one purpose or one cultural group. We note that this pedagogical move represents a sharp diversion from the “traits” model of cultural practices (see Introduction) towards a model of *practice*—to “bring the multiple dimensions of students’ lived experiences to life in the classroom” (Rosebery, McIntyre, & Gonzalez, 2001).

Defining “culture”

Across all three classrooms, varied definitions of “culture” emerged through this discussion. In the above example, when Allison says that Mangosteen is *not* part of her culture because “you can just buy it at Costco”, it brings up the question for us of what it means to talk about culture with students, how one defines it, and how one leverages “cultural” practices in the context of science instruction. In this section we briefly present the varied definitions of culture that emerged through the discussions around the self-documentation activity. We raise this point not because it is surprising that “culture” was a contested term in all three classrooms, but to raise the question (still unanswered for us) of what are design implications for making cultural practices an explicit object of inquiry in science classrooms.

In the following examples, we show classroom excerpts from all three teachers to illustrate the varied definitions of cultures from each teacher:

1. Ms. Love: culture is something that would be different from what I do: *“I also want to be able to pull out what are some of the things that are cultural to us? Anyone know what I mean by cultural to us? So if I walked into your home, what would be different from what would be in my home? If I walked in there sick, and I'm just like (starts coughing, holding her side, acting sick), what are the kinds of things would your parents do for me if they took me in, those kinds of things? Or if you walked into my home sick, what are the kinds of things I would do for you?”*
2. Ms. Evans: culture is based in your family and your ethnicity: *“I'm guessing that it's something that your parents or grandparents knew about because as I look around the room, many of us from your culture don't know about it but all the people that do know about it are of the Asian cultures. Does that make sense? And so will all who use it go home and talk to your parents and find out how they knew to use Mangosteen.”*
3. Ms. Williams: culture is handed down from your families: *“So what we're really interested in here is what your family does based on the culture that you come from. Ok? So this is something that comes down for you from your family, from your culture, that's especially important. So not something that you learned in school, but something that you learned from your family of ways to keep you healthy, ways to keep you from getting sick...So raise your hand if something that is on your self-doc, something that's on your map in front of you right now with the pictures on it, or something that you know of off the top of your head, that's something that you do when you get sick or something that you do everyday that's something that your grandparent does, or that you've learned from your family.”*

In Ms. Love’s example, her definition of culture seems to assume that there are no *shared* cultural practices—that a person’s cultural practices only count as “cultural” if they are different than someone else’s. In Ms. Evans’s example, culture is handed down through family and membership in an ethnic group. In Ms. Williams’s case, culture is only something that is learned from your family, *not* something learned in school. While each of these conceptions of culture may be incomplete in some way (ie, excluding peer groups as a site of cultural membership, thinking about shared cultural practices), they represent a starting point for us to think about how to support conversations around culture in classrooms—especially as they pertain to science. For example, the self-documentation gave teachers a glimpse of sources of certain knowledge systems around health (“my dad says that drinking tea gives you more blood”). With the recognition that students’ beliefs around health come from strong family histories of knowledge being passed down from one generation to the next (Ms. Williams’s definition of culture), teachers are less likely to see these beliefs as “misconceptions” and more as rational ideas. By recognizing

(and celebrating) differences between individuals' cultural practices (Ms. Love's definition of culture), we can begin to broaden our definitions of what counts as school science. Finally, in recognizing that some cultural practices are common among people who share certain ethnicities—and by pointing that out in science class, we begin to position students as both experts *and* members of certain ethnic groups, thereby helping students to “affirm their cultural identities” (Ladson-Billings, 1995, p. 6) at the same time that they participate in meaningful scientific learning.

Implications

This design effort represents our first attempt to incorporate ethnographic data and methods into the design of formal science instruction. In attempting to surface and leverage students' out of school expertise around health, the self-documentation technique shows promise as a way for teachers to gain some insight into their students' out of school practices. Because of the time-consuming nature of ethnographic work, thick descriptions (Geertz, 1973) are formed about a small number of participants. Self-documentation might be a way to help practitioners, with 20 or more students in their classes, gain some insight into who their students are—the multiple and varied repertoires of practice that they engage in and the corresponding areas of expertise they bring with them to the classroom.

This analysis also raises some dilemmas for us about *how best* to leverage students' culturally-based health practices in the learning of discipline-specific practices. Gutierrez and Rogoff (2003) argue that “An important feature of focusing on repertoires is encouraging people to develop dexterity in determining which approach from their repertoire is appropriate under which circumstances” (p.4). While the self-documentation task itself was successful in eliciting students' repertoires of practice around health, more work needs to be done in the design of science learning environments to leverage those practices (while knowing the histories behind them) and support students in understanding when and how to navigate between their various repertoires of practice and where there is overlap or tension between them.

Another implication we see from this study is the challenge of leveraging culturally-based practices *while at the same time* supporting the learning of disciplinary practices and content. At the same time that the self-documentation activity gave teachers insight into how to connect science to their students' everyday lives, we have more work to do to connect these practices with deep disciplinary content.

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