

Complex Dilemmas of Identity and Practice

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Received 4 October 2004; revised 28 March 2005; accepted 13 May 2005

DOI 10.1002/sce.20096

Published online 15 November 2005 in Wiley InterScience (www.interscience.wiley.com).

ABSTRACT: Identity is a complex construct, yet extremely important if we wish to understand the practice of teaching as a profession. In this paper, we examine the ways two middle school teachers talk about their identity and teaching practices and coordinate these self-reports with our own observations of how they implement a new environmental science curriculum. More specifically, we compare the teachers' beliefs about learning, goals for the classroom community and for instruction, and their knowledge of science content, and pedagogy. Furthermore, we discuss teaching dilemmas, which arise for these teachers as their identities and practices intersect and at times conflict. We argue, however, that a focus on practice and outcomes is an important, but limited aspect of what we, as a field, need to consider when attempting to understand the complexities of teaching and learning. Therefore, we continue to expand our understanding of two science classrooms as we examine the teachers' multiple identities in relation to their implementation of a science curriculum. The identity portraits from this study provide a rich and complicated account of the implementation of a science curriculum and illuminate a number of potential obstacles and pitfalls, which may inform the way we as a field reflect on curriculum and professional development. © 2005 Wiley Periodicals, Inc. *Sci Ed* 90:68–93, 2006

INTRODUCTION

In response to a strong movement in recent years promoting inquiry-based science instruction (American Association for the Advancement of Science, 1993; National Research Council, 1996, 2000), numerous programs and technologies have been developed (e.g.,

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Bguile, 2002; GLOBE, 2004; Model-it, 2004; ThinkerTools, 1999; WISE, 1998; World-Watcher, 2002). Many of these programs recognize the importance of professional development and offer training to teachers who plan to implement these programs in their classrooms. However, even when teachers participate in comprehensive training programs, there remains a large and often undocumented amount of variability from class to class in just how inquiry-based curricula are implemented. These differences have the potential to influence what, how much, and how well students learn science. Within this paper we look beyond curriculum training to better understand how teachers' identities are tied to classroom practices.

More specifically, this paper compares two teachers implementing the inquiry-based environmental science curriculum titled, *Global Learning and Observations to Benefit the Environment (GLOBE)* after attending the same training session. In a previous paper, Enyedy and Goldberg (2004) document the divergent classroom practices of these two teachers and the subsequent learning outcomes for the students. We argue, however, that a focus on classroom practice and outcomes is an important, but limited aspect of what we, as a field, need to consider when attempting understanding of the complexities of teaching and learning. While analyzing the similarities and differences in the purpose, organization, and quality of classroom interactions provides a great deal of information about how different practices are related to learning outcomes, these aspects of the enacted curriculum do very little to explain the consequential variation in teaching that we and others have found, nor does it identify the sources of that variation. In the analysis of the classroom practices of these two veteran teachers (Enyedy & Goldberg, 2004), we were left wondering why two competent teachers in similar settings made different choices about how to interact with their students and the curriculum. Was it all a contingent response to immediate concerns in the classroom, or were the differences in classroom practice due in part to some significant differences between the two teachers that would be relevant to other practitioners?

In this paper we present data from interviews with the two teachers that relate their respective professional identities to the decisions that they made in their classrooms. We also include examples of classroom talk and interaction drawn from videotape and transcript data that further illustrate the teachers' beliefs and decisions. Through our analysis, we argue that the current ways of modeling teaching (based on a teacher's content knowledge, pedagogical knowledge, beliefs about the nature of science, beliefs about the nature of learning, and curricular goals and plans) miss an important aspect of what it means to be a teacher and how decisions are made on the fly during teaching. We argue that what is missing is how these five factors are mediated by a teacher's multiple, professional identities. Currently, when identity is addressed it is as a precursor and contributing factor in one's knowledge, beliefs, and goals, but identity is not often analyzed as having a direct link to practice.

In the context of the quantitative differences between the test scores of two experienced teachers' classes and qualitative analyses of the teachers' classroom practices (Enyedy & Goldberg, 2004), we use interview data to construct portraits of the teachers' identities. These identity portraits provide a rich and complicated account of the implementation of a reform curriculum that shows the ways that both teachers' choices were rational and reasonable. Further, the analyses illuminate a number of potential obstacles and pitfalls, which can potentially inform the way we as a field think about curriculum and professional development.

THEORETICAL FRAMEWORK

If we want to understand how and why teachers make decisions while teaching, we need a theoretically driven model of teaching in context. Goodson (1991) argues that teaching is

intensely personal, and that therefore we need to understand who a teacher is and how they are situated within larger social contexts. In this vein there is a substantial body of literature that examines the relationship between teacher beliefs and teacher practice. Beliefs are usually taken to be psychological constructs that describe the structure and content of a person's thinking which in turn influence a person's interpretation of events and actions (Kagan, 1992; Nespor 1987; Pajares, 1992). Nespor (1987) argues that beliefs are a special form of knowledge, perceived by the subject as immutable and beyond personal control. Furthermore, beliefs are affective and subjective and idealizations that may differ from reality. These theoretical models also stress that beliefs are organized into higher level belief systems that relate beliefs, attitudes, and values (Pajares, 1992).

Beliefs and belief systems are often held to be derived from one's personal life history, and from cultural socialization (Eick & Reed, 2002; Nespor, 1987; Pajares, 1992). Further, beliefs and beliefs systems have been found to be quite resistant to change and to not easily succumb to argument or reason. Given the close association between one's personal life history and one's beliefs, it is not surprising that beliefs are hypothesized to reside in episodic memory and that when activated these beliefs are translated into practical action (Nespor, 1987). In this translation process, newer teachers tend to use the history of their own schooling and in particular, specific teacher role models to guide their own teaching (Eick & Reed, 2002; Kagan, 1992; Knowles, 1992). Veteran teachers, on the other hand, have a much wider array of relevant experience to draw upon. For both novice and veteran teachers, beliefs have been shown to be closely associated with lesson planning, assessment and evaluation, and to indirectly influence teacher decision making during classroom interactions (Helms, 1998; Pajares, 1992). Thus from this research on teacher beliefs, it is clear that teachers are more than their practice and that there is a close link between what teachers do in their classrooms and their beliefs as evidenced by their self-descriptions.

However, we are critical of the perspective on teacher beliefs outlined above for two reasons. First, beliefs have been shown to be hard to modify and thus they do not provide a very effective tool for professional development or teacher training. Second, while there is a link between beliefs and practice, that link is indirect and primarily manifests itself directly in curriculum planning and goals. In the remainder of the paper we work toward a model that addresses some of these limitations.

Drawing on the mathematics education literature, there is a model of teaching and teacher decision making that addresses the latter concern and directly ties beliefs to classroom interaction. Schoenfeld (1998) argues that on-the-fly teaching decisions can be seen as a function of teachers' goals, beliefs, and knowledge. In Schoenfeld's model, he first considers a teacher's planned and emergent goals. The range of relevant goals includes long-term goals for the classroom community, short-range instructional goals, and local goals that are contingent on the specific circumstances of the interaction. Second, this model considers teacher's beliefs that are assumed to prioritize the teacher's goals. For the most part, these beliefs are understood to be beliefs about the nature of teaching and learning, but he allows for the importance of beliefs about the nature of the discipline as well. Third, the model considers a range of knowledge that is relevant to the teaching process, including, subject matter knowledge, general pedagogical knowledge, and pedagogical content knowledge. However, in his empirical analyses the type of knowledge that is most often utilized is historical knowledge—knowledge of individual students—both past and present—and of the class' shared history. From these three components of the model, teachers are assumed to engage in an often unrealized "cost-benefit" analysis that yields a rational decision about what the next step in the local interaction should be.

However, while this model attempts to make a direct link between teacher beliefs and their interactions in the classroom, Schoenfeld's model (1998) has been critiqued as providing

an overly rational and logical account of teaching that does not do justice to the situated and humanistic ways that teachers struggle with and honor multiple goals and factors during teaching dilemmas (Borko & Peressini, 1998; Leinhardt, 1998). Our analysis attempts to build on these two perspectives by also considering the teacher's identity as a direct component of the decision-making model where teaching practices and identity are directly linked.

We argue that identity is a "valuable lens" to use in educational research (Gee, 2001). The notion of identity lies at the intersection between one's personal history and individual psychology on the one hand and one's cultural history and community of practice on the other hand. However, identity is a complicated construct with many definitions and interpretations. Researchers vary in their emphasis of what shapes and creates a person's identity. Some believe that external forces such as culture or other people's opinions shape a person (Gee, 2001). Others believe that a person's identity is an essential part of the individual and not changed (Cerulo, 1997). And still others believe that culture and individual agency work together to create a person's multiple identities (Holland, Lachicotte, Skinner, & Cain, 1998).

Our view of identity stems from a sociocultural perspective in which a person's identity is shaped and negotiated through everyday activities. A challenge has been to demystify the elusive nature of identity—to capture the complexity, yet provide a definition that can be a powerful analytic tool. Furthermore, we believe that a missing component in the construct of identity is practice. In this study, we examine the choices made by two teachers in their practice and seek to better understand why these choices were made.

The definition of identity that we have negotiated during this study stems from discussions of narrative definitions of identity by Sfard and Prusak (2005). We believe identity is a fluid, dynamic, recursive, discursive process in which statements about actions are translated into statements about states, and vice versa. Teachers may talk about who they are in terms of their actions or teaching practices (e.g., *incorporating* lab hands-on activities) or in terms of states (e.g., *being* a scientist). Similarly, Holland et al., (1998) wrote:

People tell others who they are, but even more importantly, they tell themselves and they try to act as though they are who they say they are. These self-understandings, especially those with strong emotional resonance for the teller, are what we refer to as identities. (p. 3)

In this study, we expand on the notion of teachers "acting who they say they are" by examining the identity discourse of two teachers and comparing it to their observed practices.

By concentrating on teacher identities, we are able to focus on the individual teacher as well as the social contexts and the institutional frameworks within which he or she finds himself or herself. Wenger (1998) points to five salient aspects of identity. First, consistent with the literature on beliefs, he notes that identity is related to one's personal history. Second, he adds that one's identity is also related to one's experience as negotiated within the context of existing cultural practices complete with their categories and cultural histories. Third, he stresses that identities are related to membership in communities. Fourth, he recognizes that people are members of multiple communities and thus one's identity is at the nexus of these multiple memberships. Fifth, he argues that one's identity in the moment is an interaction between the local and global contexts. Thus Wenger's formulation provides us a way to bridge the intensely personal nature of teaching to its very public and cultural aspects. As he points out:

The concept of identity serves as a pivot between the social and the individual, so that each can be talked about in terms of the other. . . . The resulting perspective is neither individualistic nor abstractly institutional or societal. It does justice to the lived experience of identity while recognizing its societal character—it is the social, the cultural, the historical with a human face. (1998, p. 145)

This concept of a pivot implies the centrality of identity to the study of teaching. It also reminds us that identity and identity construction are ongoing processes (Torres, 1998). Thus, this perspective on identity helps resolve our earlier critique of the existing literature on teacher beliefs—that beliefs are resistant to change. In contrast, because identity is directly linked to both one's history and one's membership in multiple communities of practice, one's identity is always both in progress and dependent of the particulars of the context. Additionally, from this perspective, identity is not merely a checklist of stable traits or reducible to a set of beliefs.

Finally, our notion of identity builds on the definition of Drake, Spillane, and Hufferd-Ackles (2001) that combines psychological constructs such as beliefs with sociological constructs of practice. They posit that teacher identities include the teachers' "sense of self, knowledge and beliefs, dispositions and orientation towards work and change" (p. 2). To this we add teachers' relationships to his/her students, the classroom community, the discipline—science in this case—and to representatives of the school administration. Such institutional relationships open the door to multiple areas of control or power that shape a person's identity and practice.

Research particular to science education has shown that teachers see their subject matter identity as their primary professional identity (Little, 1993; Talbert, 1995). Of particular importance to our study—where we compare a self-identified math teacher and a self-identified science teacher, both who are teaching science—is Helms' (1998) finding that teachers who identify with their discipline sometimes see teachers of different disciplines as fundamentally different. Conversely, this would suggest that when in a situation where they were not teaching their discipline they would see themselves as the outsider.

As we have already noted, one's identity is neither monolithic, nor stable. One's professional identity is related to and interacts with an overall sense of self as well as other types of group membership. The multifaceted aspects and multiple identities cannot be cleanly separated by the individual, nor by the analyst (Helms, 1998). As a result, the multiple identities of teachers and the contingencies of the classroom have the potential to create teaching dilemmas. Teaching dilemmas are conflicts in which there are multiple, equally viable and often unattractive alternatives (Lampert, 1985; Volkman & Anderson, 1998). Teachers often manage dilemmas, rather than solving them because choosing one side over the other leaves the teacher conflicted and as their own antagonist (Lampert, 1985). Volkman and Anderson (1998) also point out that dilemmas arise when one's different identities suggest contradictory solution paths. Their study of a first year chemistry teacher details the conflicts that emerged for the teacher as she attempted to integrate her professional identity with her personal identity. Common teaching dilemmas revolve around classroom management, beliefs about learning, beliefs about the nature of science, and one's confidence in the science content being taught, and other people's and institutional expectations (Volkman & Anderson, 1998; Walker, 1991). In this study we identify teaching dilemmas that our veteran teachers encounter, and use the construct of identity to illuminate how they navigate these dilemmas.

METHODS

The argument advanced in this article is not the story we set out to tell. When we began this research we intended to focus on the students and to document the ways that new technologies create new learning opportunities for students and teachers. However, it became increasingly clear that a natural experiment was emerging. The two teachers we were collaborating with, by all accounts, seemed very comparable. They were both very experienced teachers, with almost 20 years of experience each. They were both teaching a

group of bilingual Latino students¹ within the same school. They both participated in the same 4-day GLOBE training session. Further, after the training, both teachers expressed concerns about how well they really understood the science content of GLOBE. Additionally, we provided both teachers the same amount of support (weekly meetings prior to and during the unit) and in-class technical assistance. Finally, based on our planning sessions the two teachers seemed to espouse very similar professional beliefs and values.

However, within the first week of implementing the GLOBE curriculum, we began to notice very striking differences with regard to how the teachers enacted the curriculum. These differences may have contributed to differential learning outcomes for the students (Enyedy & Goldberg, 2004). As a result, our research focus branched and we began to pursue the following research questions: What accounts for the observed differences in these two teachers' practice? Can we predict (and thus accommodate within the curriculum) these differences in student learning based on the teachers' beliefs, knowledge, and goals? Are there factors beyond individual characteristics, such as identity, that affect how these teachers enact a new, reform-based curriculum?

THE SETTING AND CURRICULUM

The GLOBE curriculum was implemented for 3 months by three² teachers in a K-8 school in an urban area of Los Angeles. The school's students are predominately Latino/a (97%) with a high percentage of English language learners (61%). The school itself is located within an industrial area—making environmental education particularly relevant to the students, teachers, and community.

Both teachers in this study—Ms. Cook and Ms. Whyte³—are experienced teachers, each teaching over 20 years in the same district, the last 4 years together at the same school. In addition to their teaching credentials, they both pursued masters degrees—Ms. Cook in education and Ms. Whyte in multicultural education. Ms. Cook is also pursuing a supplemental authorization in mathematics education. They both use Spanish, their second language, to aid the 30–50% of their students that need such support.

Global Learning and Observations to Benefit the Environment (GLOBE) is an international project (developed and funded by a Federal interagency program including NOAA, NASA, NSF, and the EPA) that promotes learning environmental science by having students engage in authentic science via inquiry-based hands-on science-learning activities and scientific data collection protocols. GLOBE links students, teachers, and scientists in a coordinated effort to learn about the earth's environment through observation, data collection, and analysis. Students who participate in the GLOBE project collect environmental data in their local area and transmit their data via the Internet to an international database. Students then have access to data displays that are based on the combination of their data and the data collected by other students from schools around the world. In this way students learn how to conduct rigorous scientific experiments, analyze data, and draw conclusions based on their findings. Finally, the GLOBE program puts students in contact with scientist mentors who are using the GLOBE data in their own scientific research and provide feedback to the students about their data and analyses.

¹ There are, however, some differences between the two classes. First, Ms. Cook's class was a multiage classroom containing students from the sixth and seventh grades. Ms. Whyte's class had only seventh-grade students. Second, there seemed to be some tracking of students at this school. Ms. Cook's class was considered to have the high achievers, which was confirmed by our analysis of the students SAT-9 test scores. These differences are accounted for in our analysis of test scores in the two classes.

² Only two teachers are examined in this paper. The third teacher was excluded because he taught a different grade level (the eighth grade) than the other two teachers.

³ Both names are pseudonyms.

The teachers' decision to implement GLOBE was part of a school-wide effort to integrate technology into their everyday practice. This focus on technology was sparked by a donation by the Microsoft Corporation of over 80 computers. A month prior to implementing GLOBE, the teachers attended a 4-day training session. Both classes engaged with the GLOBE activities for 60–90 min a day for 3 months at the end of their school year. Also, beginning 2 months prior to the implementation, the teachers and members of the research team met once a week for 2 h/week to plan the activities, practice the GLOBE protocols, and reflect on the program's progress and difficulties encountered by the teachers.

The Interviews

The analysis presented here relies primarily on interviews with the teachers and their self-reports of their beliefs and the decisions they made while teaching GLOBE. We triangulated the themes found in these interviews with recordings of their actual practice during GLOBE. Both teachers were interviewed three times immediately after the completion of the GLOBE curriculum. Each interview was in a different format. The first interview was a semistructured clinical interview with each teacher individually. Both teachers were asked the same questions, although the follow-up questions were unique. The second interview was a semistructured clinical interview where the teachers were interviewed together. Both of these interviews focused on the teachers' beliefs, goals, and reflections about their practice in general terms. Additionally, with one of the teachers, Ms. Cook, we had the opportunity to have a number of additional informal interviews where we were able to follow up on some of the topics; these additional interviews are labeled as "conversations" as they appear in our analysis.

Each teacher was also interviewed individually in a cued recall format. In these interviews we framed the interviews around videotapes of their GLOBE implementation. The videotapes were chosen by the researchers after reviewing and summarizing the classroom video footage. We chose episodes that showed the teachers enacting the same lesson in different ways, but neither the criteria nor the differences were told to the teachers at the time of the interview. Each teacher saw excerpts from their own classroom and was asked about the decisions they made and how they came to these discussions. Each teacher was shown three excerpts a few minutes in length. The intent of the cued recall interviews was to help the teachers reflect about the particulars of implementing GLOBE and how it interacted with their existing practices.

The interviews were analyzed using the techniques of grounded theory (Charmaz, 1983). We were cautious not to categorize the teachers of this study into arbitrary or predefined belief categories or identities, but attempted to use the particulars of our observations and interviews to sketch these teachers and their multiple identities (cf., Helms, 1998). Interviews were first analyzed for emergent analytic categories that characterized the teacher's own stories about their practice, beliefs, goals, and reflections about their efforts to implement GLOBE. The transcripts were then examined systematically for every example of each category across all interviews. In this paper, we present a few representative quotations to illustrate some of these analytic categories that highlight the similarities and differences between these two teachers.

Thus the first analytic section of this paper provides a thematic organization of the teachers' reflections. The question that remains is, are these reflections constitutive of their identities? Do these identity portraits help to explain why the two teachers' practices diverged? To address this question we triangulate the reflections with the videotapes of their practice in two separate ways. First, we looked for confirming evidence in our videotapes. For example, if the teacher in an interview talked about the importance of highlighting the

social relevance of the content because of her own values, then we would look for cases where in a lesson that social relevance was a prominent part of the lesson. These excerpts are integrated with the teachers' reflections.

Second, we triangulated the interviews with what we refer to as teaching dilemmas. The teaching dilemmas are necessary because recovering a person's identity from their activity is no simple matter. Videotapes provide a selective, but good, record of what has happened. However, because people are busy getting things done and are not taking the time to narrate their activity, videotapes provide very little information about people's intentions or the reasons behind their actions, especially actions that have become routine over time. For this reason, our second strategy to triangulate our data was to look for dilemmas, which we believe are occasions where people's intentions and identities are more likely to become visible. It is our conjecture that identities do work for individuals as they go about their lives and make decisions. However, we do not think this is a simple causal relation, there is a complex and at times tangled web of relations between teachers' life histories, the multiple and at times conflicting identities that have been developed over the course of these histories, their existing set of routines and practices, and the contingencies of the moment.

Thus we looked for places in the videotapes where we thought there was some sort of breakdown, contradiction, or emerging incoherence. While this was somewhat subjective we used two main indicators. First, we looked for places where what was happening did not seem to fit the descriptive model of the teacher's identity we had constructed. For instance, if the teacher had made a strong statement about being the sort of teacher that values peer interaction but was assigning a lot of individual seatwork, we expected that this would be a productive place to look for the intersection of identity and practice. Second, we looked at the classroom interactions for the teacher's affect. We made the conjecture that at times when there was an emerging teaching dilemma that touched on their identity as a teacher, we should see some sort of emotional shift as they recognized the dilemma. The second analytic section presents our analysis of these teaching dilemmas. By triangulating the interviews with the observations of their practice in this way, we hope to show the relevance of the teacher's reflections about who they are to their lived practice.

RESULTS

As stated earlier, we analyzed the interviews to better understand the sources of variation identified in Enyedy and Goldberg (2004). Two important sets of results from the previous study—learning outcomes and classroom practice—are relevant and are summarized below.

Learning Outcomes

Student scores in both classes improved significantly on the posttests based on a *t*-test. This suggests that the students in both classes did learn some environmental science concepts ($t = 8.45$, $p < 0.01$). However, an analysis of covariance (ANCOVA) using the change in pretest and posttest scores (i.e., gain in scores) as the dependent variable and holding SAT-9 scores constant as a covariate, indicated that the teacher was a significant factor ($F = 8.1$, $p > 0.01$). This suggests that the teacher, as a proxy for the classroom community, was a strong predictor for the learning gains and that the community in Ms. Cook's class led to higher learning outcomes (Enyedy & Goldberg, 2004).

Classroom Practice

Video analysis of the teachers' practice revealed that the teachers were organizing their classroom discourse in different ways and that this may have contributed to different learning

outcomes (Enyedy & Goldberg, 2004). First, the ways the teachers framed the on-going investigations differed. Ms. Cook situated each activity in the context of prior activities and the on-going questions developed by the students. Ms. Whyte framed the activities in a more isolated manner, adhering to the questions generated in the curriculum, but not making connections among investigations. Second, the two teachers differed in the degree to which they stressed following and implementing the scientific protocols and procedures specified by GLOBE. Ms. Cook often tried to elicit student-generated strategies for how to pursue the question. On the other hand, Ms. Whyte stressed the importance of closely following the scientific protocols and procedures. Third, they positioned themselves differently in terms of their relationships to the students. Ms. Cook positioned herself with the students in a somewhat symmetrical relationship as a co-inquirer, while Ms. Whyte positioned herself in an asymmetrical, maternal relationship of caring coupled with authority.

The Intersection of Beliefs, Practice, and Identity

Our objective for interviewing the two teachers, Ms. Cook and Ms. Whyte, was to begin to understand the reasons behind the differences in their implementation of GLOBE. Through informal conversations with these teachers, we noticed seemingly subtle differences in their beliefs, goals, and background knowledge. We wanted to see if there were systematic differences related to their identity or identities that would account for varying practice. To do so, we explored Ms. Cook and Ms. Whyte's self-reported accounts of the decisions they made and their rationales. More importantly, we set out to learn more about how they see themselves as teachers at their school, including their relationships with students, the school, and the curriculum. The results of the interviews were coded based on the teacher's goals, beliefs, knowledge, and other characteristics related to identity.

In the remainder of this section, we first present a descriptive model of Ms. Cook's goals, knowledge, and beliefs and then present a model of Ms. Whyte using the same categories. More specifically, we examine the goals that each teacher has in terms of the classroom community, roles, and relationships, in addition to looking at their instructional goals. The beliefs we examine include the teachers' views of the nature of teaching and learning and the nature of science. We also explore the teachers' background knowledge, including science content knowledge, pedagogical knowledge, and pedagogical content knowledge. These models paint a clean, and somewhat coherent portrait of how these teachers see themselves as professionals. To counter this simplistic and casual model of the relationship between identity and practice, we present a few examples of the types of teaching dilemmas we observed when their multiple and fluid identities, came into contact with the multiple and shifting practices, goals, and contingencies of real teaching and learning moments. In our presentation of these dilemmas, we attempt to keep our analytic focus on how the teachers are constructing their identities in the moment, how aspects of these identities at times contradict each other or conflict with the way their current activity is organized, and how their identities and dilemmas are navigated and negotiated in their classroom practice.

Ms. Cook

Ms. Cook teaches all subjects within a classroom that is alive with science, including animals and plants on counters all around the room. She believes that such a community, "makes learning fun and it makes learning happen." Some might consider her classroom to be chaotic at times because in her own words she has "kids talking to each other, definitely learning from each other, definitely learning from me, too" (Interview 1A, 5/30/01). Furthermore, many of our observations of her teaching situate Ms. Cook alongside students as all members of the classroom explore scientific concepts.

Beliefs

Nature of Teaching and Learning. In talking about her beliefs about how students learn and her role as a teacher, Ms. Cook stressed the importance of students being active participants in the classroom. “Kids learn by doing.” She wants them to discover things on their own instead of following a step-by-step science activity. She posits:

I don’t want to give them answers. And I don’t really care if they can answer a multiple-choice question right. I want them to have some deep understanding and I want them to be excited. . . . I want them to see that there’s all different ways we can learn. (Conversation 1, 11-4-01)

It is through discovery, she believes that students learn best. Ms. Cook begins with students engaging in some sort of free exploration or even “goofing around to see how it might work.” This is followed by students generating their own conjectures, which they must put in writing prior to engaging in any formal inquiry. While implementing GLOBE, Ms. Cook incorporated these teaching practices, even when it was not listed as part of the GLOBE lesson or protocol.

Another key factor to learning is Ms. Cook’s beliefs about the value of reflection and student talk. Summarizing her own values she states,

Number one, writing it down, thinking about it and writing it down makes them have to have an opinion. It doesn’t mean they can’t change that opinion, but I want them to have an opinion. Also, I want them to see it is okay to be wrong because that is how we learn. And I want them to listen to their peers, to other people. (Interview 3A, 6/20/01)

Learning is not simply about reciting facts, but about exploring opinions through communication. Ms. Cook believes that social interaction is paramount to learning and that these interactions promote reflection.

Finally, Ms. Cook thinks that students need to see the connections between what they are learning and their own lives. For example she says, “Learning needs to be meaningful and real. It is imperative that the things they do in the classroom are connected to their lives and real.” Further, Ms. Cook thinks that school science, and the GLOBE curriculum, is consistent with this instructional goal stating, “Science just falls into the real category so easily” (Interview 2A, 6/13/01).

During science activities, Ms. Cook incorporates her views of the nature of teaching and learning into her teaching practices. She moves frequently between whole class and small group work, encouraging students to interact in many ways while exploring a concept. Students are expected to communicate with their peers and teacher about topics. Also, Ms. Cook often connects science concepts. Topics are connected to other science concepts as well as to familiar situations (including the students’ community). For example, in a lesson about soil and water temperature, Ms. Cook in the introduction directs students to “talk to your friends about a time that you have been to the beach and about how, how the ground felt, and how the water, how the water felt” (Classroom Video, 4/25/01). This directive communicates to students that they will be discussing this topic with peers and connects it to a familiar activity for these students—going to the beach.

Nature of Science. During our interviews, Ms. Cook talked very little about her beliefs regarding the nature of science. To the degree that she did, those beliefs seemed to stem from her beliefs about the nature of mathematics and mathematics pedagogy. For example, in discussing her goals for a particular activity where the soil’s capacity for absorbing water was compared to a sponge, she said:

In math I say there may be one right answer, but there is [*sic*] many ways to get to it. I mean, it's the same way in science. I want them [to know] there isn't a right answer. I mean there could be many ways that we have not even thought of. (Interview 2A, 6/13/01)

This belief about multiple solution paths that is borrowed from her beliefs about math is closely linked to the way she articulates her science pedagogy discussed below.

In classroom interaction, Ms. Cook often stresses that there are multiple approaches to problem solving. During a lesson in which students investigate soil and water temperature, she says to the class,

We have a lot of different answers. . . .there was a, like a lot of agreement on at night, the water, the, the soil cools down or the sand cools down, but we weren't positive, some people said yes, some people said no about the water. So, we're going to do an experiment that I hope can answer that question for us. And, we have to kind of figure out later on why. (Classroom Video, 4/25/01)

Without evaluating particular opinions, Ms. Cook paraphrases several responses that she heard while listening to small group talk.

Ms. Cook further explained her views of multiple approaches to science and areas of teaching during an interview. Responding to what she hoped students walked away with from a science activity, Ms. Cook stated, "There's a lot of ways to do things. That all ways are valid and there's always a better way." In science, Ms. Cook wants students to walk away with an understanding that there are a variety of ways to approaching an experiment. Yet, there are better approaches. Moreover, Ms. Cook said that she feels that the majority of her students walk away with this concept.

Goals

Classroom Community, Roles, and Relationships. Ms. Cook wants to be perceived as a learner and as just one of many "teachers" in the classroom. From our video analysis (Enyedy & Goldberg, 2004), we termed this role "co-inquirer." In reflecting about her practice and her role in the classroom, Ms. Cook states:

Students have told me that what I need to do, is if somebody's struggling, sit down next to them and help them out. Before I didn't do that that much. I mean it sounds so dumb that I didn't do that, but I just—I don't know, my philosophy was a little different. And it's okay to be the teacher. (Interview1A, 5/30/01)

The opening phrase in Ms. Cook's response hints at her relationship with students. They have a relationship where students can talk to her about her teaching practices. Students are seen as part of a community of co-inquirers where students share information.

Ms. Cook is not rigid in remaining in her role as a co-inquirer, as the quotation above indicates, Ms. Cook will help students as a more knowledgeable participant. Yet she continues to see her main role in the classroom as a questioner, "because I want them to start asking themselves questions." She states that she does not "want to be the center of attention," because she wants her students to become independent learners.

Ms. Cook's role as a co-inquirer shapes and is shaped by her expectations of the classroom community. For example, Ms. Cook feels it is important to develop relationships with her students that take her out of the role of being the fountain of knowledge for the classroom. Instead, she strives to instill a sense of belonging to a community in which all members work together to discover new things and solve problems. Her role in this community is

still privileged over the students, but she avoids being the sole authority for what counts as knowledge in the classroom.

For example, when students have the floor, such as when they are presenting their “Science Talks,” Ms. Cook will not answer other students’ questions. During a science talk the presenter is the teacher. So, Ms. Cook positions herself as a learner or co-inquirer with the students. Science talks are verbal presentations of a “family project” done mostly at home. Typically the students each choose their topic and parents are invited to the presentation. In one case a student, Walter, made a presentation both his parents and little toddler brother were in the classroom. After Walter finished and asked if there were any questions, a fellow student directed a question to Ms Cook. She replied, “No soy experto! Ask Walter!” In ways like this, Ms. Cook plays out her perspectives on being both a teacher and a learner.

Consistent with this communal view, Ms. Cook sees her students as entire human beings, not just learners, and hopes that they see her similarly (as a whole person). Ms. Cook states, “I mean I really feel like I’m not just a teacher, I mean I’m a really important person in their lives and they are in my life, too” (Interview 1A, 5/30/01). She takes them with her on excursions with her son to cultural institutions such as the Los Angeles County Museum of Natural History. Ms. Cook takes pride in living in the same community as her students. She describes her place in the community: “I shop here. I go to the same church the kids go to, the major Catholic Church here. . . . I’m President of the Friends of the Library and many of my kids are in . . . reading groups there. I want them to see me as a person” (Interview 1A, 5/30/01). Ms. Cook cannot imagine teaching without these relationships. When asked about this personal type of relationship, she responded, “Without them I wouldn’t be effective at all.”

Instructional Goals. Building on her view of being a part of the community, one instructional goal Ms. Cook identified for her students was the need to see their education as a tool and for them to become activists within their community. Ms. Cook wants her students to understand “what they did and what they do in science can really affect more than just them.”

Another of Ms. Cook’s primary instructional goals relating to the GLOBE curriculum was for her students to learn how to engage in the process of inquiry. After participating in the GLOBE curriculum, she wants her students “to know what they do and what they did as far as a protocol, as far as taking all this atmosphere stuff every single day, [GLOBE Atmosphere Protocol] that they are scientists, and real scientists use that information” (Interview 1A, 5/30/01). The students’ evolving identities are important to her, in part because she wants students to see the real-world applications and importance of what they do in science class. When we asked her about how much her students had learned from the experience she said: “I would say maybe like about three or four of them don’t understand really” which means that about 90% of her students understand the process and implications of the curriculum.

Knowledge

Science Content Knowledge. Ms. Cook feels that throughout her science education experiences as a student, she never fully understood the material. She comments, “I really never understood, but I always wanted to understand.” She does not view herself as a scientist or even a science teacher with all the answers and at one point she even goes as far as saying that she is unsure how a scientist thinks. Ms. Cook identifies more as a student than as a scientist, as mentioned previously: “I have just as much to learn from them as they do from me.” She also says that it is “very clear, I’m not a science teacher and [my students] know that but let’s do this, let’s learn together.” Most likely, Ms. Cook’s lack of confidence in the area of science is part of the reason why she values a collaborative classroom in which she positions herself as a co-inquirer learning side by side with her students.

Pedagogical Knowledge and Pedagogical Content Knowledge. While Ms. Cook taught the same activities from the GLOBE curriculum as Ms. Whyte, their implementation was dramatically different. It is likely that differences in pedagogical content knowledge contributed to these differences. As a self-identified mathematics teacher teaching science, part of the reason for taking on the role of co-inquirer in the class may stem from Ms. Cook's unfamiliarity with the content knowledge and content knowledge pedagogy.

One activity that highlights this difference was one entitled "Soil as Sponge," where a student's task was to figure out how to measure the amount of water in a soil sample. They used a sponge to represent soil. Ms. Cook had her students briefly write how they might measure water in a sample of soil brought in from their outside classroom planters. Then the students were presented with equipment they could use and they had to design their own methods in groups. Each group presented their method, and they were compared to create a classroom method.

Ms. Cook's pedagogical approach was premised on the assumption that there are multiple paths to answers and that there is no one right way. She did not want to adopt an authoritative position in the classroom so that her students would come to the conclusion "that my way is not always the right way. Or the easiest way." She thinks it is important for her students "to try their ways, and for their ways to be validated. Questioned also, but validated definitely." For Ms. Cook, the point or the take home message of the activity is explained below:

It's not how to measure the soil and water. Or the water and soil. What I would hope that they would walk away with from there is that there's a lot of ways to do things. That all ways are valid, and there's always a better way. And we can always learn from each other. That's basically, really, when you come down to it. (Interview 2A, 6/13/01)

As mentioned in the discussion of her beliefs about learning, Ms. Cook believes that students learn best by discovering and this is consistent with her pedagogical knowledge and approach. She explains:

Step one, Step two, Step three. I hate that. Because I don't think kids are going to learn anything. . . . If I tell them what to do, they're not thinking. . . . So I think when you discover things on your own or you try to do things on your own, you're thinking. (Interview 2A, 6/13/01)

Summary of Ms. Cook. Ms. Cook views herself as a co-learner or co-inquirer with the students. A key part to this role is to encourage all inquirers to ask questions. Ms. Cook believes that students should be active participants, learning as they "do science." Social interaction is a key to activities, moving beyond repeating facts to exploring science ideas through communication with others. Ms. Cook also believes that it is important to make learning meaningful by connecting ideas to their personal lives. Consistent with this belief, her instructional goals include students learning how to engage in the process of inquiry and understanding how to use scientific information, including in community settings. In her view, the nature of science involves multiple approaches to solving a problem. Ms. Cook does not view herself as having a strong science background, which intersects, we believe, with her goals and beliefs.

Ms. Whyte. Ms. Whyte also teaches all content area subjects. Ms. Whyte believes that learning takes place when there is "social interaction, so that they're [kids] working with other kids, rather than in isolation. And also, the more real the experience of doing whatever it is, is the better" (Interview 1B, 5/30/01). Her role in the classroom is maternalistic,

placing an importance on safety and comfort levels. Ms. Whyte's implementation of the GLOBE activities varied significantly from Ms. Cook's with an emphasis on following the directions of the protocols and typically organizing the class either into whole class, teacher led instruction *or* small group work on experiments in which she would check on the progress of each group. We argue that the varying practices of the two teachers are due, at least in part, to the different identities of these teachers.

Beliefs

Nature of Teaching and Learning. In talking about her pedagogical approach and theory of learning, Ms. Whyte stressed the importance of students being active participants in the classroom and learning through peer collaboration. In response to a direct question about her beliefs she stated, "I think that kids learn best with . . . social interaction." Ms. Whyte also believed effective learning was more likely when the contexts for learning were authentic. She states:

The more real the experience of doing whatever it is the better . . . That somehow what they're doing has a connection to their lives. And it is a real thing. It isn't just one of these things that "Ms. Whyte" wants you to learn or remember. (Interview 1B, 5/30/01)

Nature of Science. Although Ms. Whyte believes that learning experiences need to be authentic, she did not believe that within the constraints of school (as it was organized at her school), that this was possible. She argues, "Unfortunately, what we do in class, in science, never has the real-world feature that I would like." It is worth commenting that she is referring to a curriculum that involves students going outside the classroom to collect their own environmental data, and that this data will presumably be used by other scientists for real research—two aspects that on the face seem to be consistent with her views on authenticity. Still, she continues:

When you're out there in the real world, doing real science, where scientists really do it, it's real. You just can't fake the reality. And it's a sad thing because it means the teaching of science is always going to be abstract. It just has to be. Even if you have a lab and you have [Bunsen burners], it still isn't a criminal lab, where you really want to know what is that substance, and there's a good reason for it. (Interview 1B, 5/30/01)

In practice, during the GLOBE activities, Ms. Whyte places a great deal of emphasis on the students following directions. This emphasis seems to be connected to Ms. Whyte's belief that for scientists to use the data, it must be obtained accurately—following scientific standards. For example, in the soil as sponge activity described earlier, where the students' task was to figure out how to measure the amount of water in a soil sample, she organized the lesson differently than Ms. Cook. Ms. Whyte listed the procedures on the front board for her students to follow, went over them step by step, and then students generated data. Each group presented their data and it was compared to other groups. Similarly, during an activity investigating soil and water temperatures at various depths, Ms. Whyte demonstrated step by step how to carry out the experiment and then students spent the rest of the period following these directions.

During another activity examining soil nutrition, Ms. Whyte asks a group, "Are you following directions?" when they are struggling. Then later in the period Ms. Whyte approaches another small group that is struggling:

Did you read it [the directions]? . . . Do it the way it tells you. Read. Read it. And play with the color, the way it tells you to do it. It has specific directions. You need to follow every word like lightning will strike you dead. (Classroom Video, 5/17/01)

The directions seem to be the constant she returns to when her students are having difficulty. In her mind, these important directions will lead you to the final product.

This example of Ms. Whyte's practice seems consistent with her belief that there is a right way to do science, but not a right or wrong answer. She argues:

But in science particularly, whether you get a certain result or another result, neither one is right. If you've done the protocol or you've done the activity correctly, whatever result you get is the result you get. There is no right or wrong. (Interview 2B, 6/13/01)

While this notion that there is no right or wrong appears similar to Ms. Cook's idea of no right answer there is an important difference. The answer for Ms. Whyte is generated from doing a protocol or experiment correctly following directions exactly.

Goals

Classroom Community, Roles, and Relationships. Although never stating it explicitly, Ms. Whyte seems to see her role in the classroom as a maternal one. For example, she values making the students feel comfortable and safe. She states, "Number one, I want them to feel safe. Not just physically, but emotionally . . . But I think that I do best with students when they do feel safe and comfortable" (Interview 1B, 5/30/01). She is reflective about the ways that this type of community impacts her teaching and classroom management, explaining:

Well one of the minuses is that sometimes kids take advantage of me considerably, because they know I want to maintain a sense of good will. And I feel like I don't have the upper hand at all times, which I'm not so sure that that's necessary, but I certainly don't. And other times, I think it's helpful because I can diffuse problems before they become volatile and things explode. (Interview 1B, 5/30/01)

As indicated in the above quotation, the maternal and authoritative roles as a teacher, for Ms. Whyte in particular, are fluid and overlapping.

As discussed in detail within Enyedy and Goldberg (2004), Ms. Whyte also creates a maternal role through her use of language. Ms. Whyte frequently refers to students using endearing terms: honey, dear, mister, etc. This use of language may also help students feel comfortable, while simultaneously setting up the teacher's maternal, authoritarian role.

Another role or responsibility of the teacher, for Ms. Whyte, is to make learning engaging for students. To some degree she prioritizes this above her specific instructional goals, "I judge how successful I am by how engaged they are, more in that than I do actually in any kind of assessment I'm able to give. That really is to me the most real and important assessment" (Interview 1B, 5/30/01).

Instructional Goals. Ms. Whyte's primary instructional goal is for students to understand science concepts, which she describes via an analogy with mathematics:

Knowledge alone is not enough. They have to understand. And just knowing six times eight is 48 is just a piece of knowledge. But if you understand that that means six groups of eight and also that's the same as eight groups of six, you have a little piece of understanding there that you can apply to other things. So understanding is what I would really like to see. (Interview 1B, 5/30/01)

Ms. Whyte seems to place an emphasis on a deeper understanding of science concepts rather than merely repeating isolated facts.

Finally, Ms. Whyte had an overarching goal for her students to become socially conscious and stewards of the environment. Part of the reason for this was Ms. Whyte's own identity. Ms. Whyte talked about herself as a "child of the 60s . . . raised by a mother who talked all the time about philosophy and racism, injustice." She has been witness to a lot of politics and says she has become "radicalized."

It [GLOBE] says it has to do with the environment, but it really doesn't have to do with us being responsible for the environment. It has to do with studying the environment and leaving right there. And, I think that's an enormous lack . . . That's just part of my personal beliefs I guess that we are responsible. And, the inaction is certainly as powerful as action. And I would rather have the kids on the side of making a positive contribution to the world and to themselves, their community . . . I would really like it if they walked away with the realization that pollution is caused by us. We, and because we cause it, we also might be able to control it or abate it. (Interview 1B, 5/30/01)

It is worth noting that Ms. Whyte's comments regarding pollution are specific to GLOBE. She feels that students must assume responsibility for making a contribution to their surrounding communities, and that she wants her students to be caring human beings. Furthermore, Ms. Whyte identifies environmental science with both social activism and scientific concepts.

Knowledge

Science Content Knowledge. One apparent distinction is how these teachers relate to science. In the past, Ms. Whyte has had positive experiences with science and sees herself as a "very knowledgeable layperson who is interested in science." She describes her on-going history with the discipline:

I've always been a reader and I've always been interested in science, but as a layperson. I've done archaeology. I've volunteered for Earth Watch programs. I've gone around and worked with scientists as a lackey. . . . But I can't understand, obviously, high-level science, but I am a very knowledgeable layperson. And I also love that stuff. I just love it . . . " (Interview 1B, 5/30/01)

Despite Ms. Whyte's involvement in science, she also expresses some concerns about her content knowledge and how that would affect the way that she could mediate her students experiences, "I am a little, though, you know, I'm out of my depth in GLOBE." In part because the content was new to her and that made it difficult for her to "anticipate what I needed to tell the students so that they would have a successful experience." Ms. Whyte did not have her usual comfort level while teaching GLOBE content. Therefore, her classroom interaction may have been very different compared to when she teaches more familiar science activities, such as nutrition or energy.

Pedagogical Knowledge and Pedagogical Content Knowledge. As implied in the last quotation, Ms. Whyte's pedagogical approach includes a central role for herself to provide content at a level appropriate for her students. When describing the planning and implementation of science activities, she comments, "I learned a great deal. It was wonderful, the things that I learned. And then I was able to teach them to the students as a level we could all deal with" (Interview 1B, 5/30/01). In other words, she saw her role as a mediator

between the activities and the students. She learned the material first and then she presented the knowledge to her students.

However, Ms. Whyte seems to be aware of the tension between her beliefs about student-centered learning and her science pedagogy. This tension is reflected below as Ms. Whyte explains her role when students work in their groups.

I have a tendency to want to be the one that knows it all. And rather than encouraging students to find their own answers and struggle with not knowing and trying to figure things out, I have a great tendency to want to impress them by how much I know. . . . And I don't like that in myself, but I do it. When I'm more conscious rather than less conscious, I don't do it. I encourage them to . . . I say, well, that is a problem. How are you going to deal with that? But most of the time that doesn't come out of my mouth. Most of the time, what comes out of my mouth is oh, well, why don't you try this or that or this or that, and I'm pushing them toward my answers. (Interview 2B, 6/13/01)

Summary of Ms. Whyte. Ms. Whyte seems to view her role as teacher maternally, with an emphasis on helping students feel comfortable and safe. It is important to her to make learning engaging. Furthermore, Ms. Whyte's primary instructional goal is for students to have a deep understanding of science concepts. She also has an overarching goal for students to become more socially conscious. Although Ms. Whyte does not feel it is possible with given constraints, she believes that it is important for science to be real or authentic. Part of this authenticity leads to a focus on following directions to obtain accurate results. As long as you follow the protocol, there is no right or wrong (in terms of results). Ms. Whyte has a strong background and interest in science; however, she is not as secure in the science content within GLOBE. During the implementation of this curriculum, Ms. Whyte felt that her role was to learn the material and then present it to students. Because of the intersection between identity, background, and beliefs, Ms. Whyte's implementation of another science curriculum, in which she has a higher comfort level, may look very different than the interactions we observed.

Comparison of Teachers

Both Ms. Cook and Ms. Whyte had an overarching goal for students to become socially conscious. This goal stemmed, at least in part, from their identity. It is worth noting that while Ms. Cook's comment was about activism in general, Ms. Whyte's comments about social activism are specific to GLOBE. Still, they both feel that students must assume responsibility for making a contribution to their surrounding communities, and they both want their students to be caring human beings.

Instructional goals vary in these two classrooms. That is, they have very different understandings about what is important about the process of scientific investigation. The answer for Ms. Whyte is generated from doing a protocol or experiment correctly, while for Ms. Cook, it is important for her students to explore and work together as they generate and compare protocols.

Table 1 summarizes the goals, beliefs, and knowledge of each teacher. Many of the quotations from the interviews that helped to describe Ms. Cook and Ms. Whyte's goals, beliefs, and knowledge also highlight their professional identity. For example, Ms. Cook draws a direct connection between her own identity as an activist and her long-term instructional goals for her students to become activists in their own community. The same could be said of Ms. Whyte's "child of the sixties" comment in relation to her goal for her students to become stewards of the environment.

TABLE 1
Teacher Differences in Relationships to Various Components and Contexts

		Ms. Cook	Ms. Whyte
Beliefs	About learning	<ul style="list-style-type: none"> • By doing • By discussion • By reflection • Relevance 	<ul style="list-style-type: none"> • Social interaction • Fidelity w/professional practice
Goals	For the classroom community	<ul style="list-style-type: none"> • Teacher as co-inquirer • Personal relationship via her role in the community • Community watchdogs 	<ul style="list-style-type: none"> • Teacher as expert • Personal relationship via promoting safety and comfort • Environmental stewardship
Knowledge	For instruction	<ul style="list-style-type: none"> • Process of inquiry 	<ul style="list-style-type: none"> • Scientific understanding
	Of science content	<ul style="list-style-type: none"> • Does not understand 	<ul style="list-style-type: none"> • Enjoys/layperson • Out of her depth
	Of pedagogy	<ul style="list-style-type: none"> • Multiple paths/invented strategies (borrowed from math pedagogy) 	<ul style="list-style-type: none"> • Need to present concepts at a level the students can understand • Emphasis on following directions
	Of students (expectations)	<ul style="list-style-type: none"> • 90% understand process of inquiry 	<ul style="list-style-type: none"> • 30% understand science content

However, these aspects of their identities can be argued to be precursors to their goals, beliefs, and knowledge, which in turn influence their classroom practice and on-line decision making. In the following section, we argue that certain aspects of the teachers’ identities also have a direct role in the decision-making process. When teachers encounter teaching dilemmas, the process of resolving these tensions and contradictions often draws on, but is not determined by, their sense of whom they are. In this case we argue that these two teachers rely on their identities when they struggle to honor multiple, conflicting considerations in their teaching. Thus, identity has a direct role in teacher decision making—particularly in modeling how priorities are established. At the same time, it was often the teacher’s multiple, potentially relevant identities that contributed to the dilemma in the first place. Thus, identities are also being fluidly reconstructed and reconfigured as a result of their practice.

DISCUSSION OF TEACHING DILEMMAS

Ms. Cook’s Teaching Dilemma

Teaching GLOBE presented Ms. Cook with a teaching dilemma. The premise and instructional objectives of GLOBE are sometimes at odds with her beliefs about how students learn and how to teach science. A major strength of the GLOBE curriculum is its authenticity. Students collect local data and enter that data into an international database that is used by real scientists for their environmental research. However, for the student data to be useful to scientists it must be reliable and comparable to other data. GLOBE attempts to achieve reliability and comparability by scripting out the data collection process into detailed “protocols.” However, following predefined and potentially meaningless procedures conflicts with some of Ms. Cook’s beliefs about the nature of learning. For example, it seems to

conflict with her statement, “Step one, Step two, Step three. I hate that. Because I don’t think kids are going to learn anything. . . . If I tell them what to do, they’re not thinking So I think when you discover things on your own or you try to do things on your own, you’re thinking” (Interview 2A, 6/13/01).

Ms. Cook often seems to resolve this tension in favor of her beliefs about how students learn. The question is why? Given her own statements that attest to her lack of confidence in the domain, why does Ms. Cook abandon the goals and guidelines of the curriculum? And does the way she navigates the teaching dilemma directly contribute to the success of her students on the posttest?

The list of considerations suggested for a “cost-benefit” analysis by Schoenfeld (1998) does not seem to adequately address why certain high level goals would be prioritized above others in the teacher’s decision making. We argue that a neglected aspect of this model is the degree to which these different goals are aligned with Ms. Cook’s professional identity. In this case her identity as a mathematics teacher and dis-identification with science.

The cost-benefit explanation is that Ms. Cook chooses to ignore the GLOBE protocols based on a benefit analysis that weighed the potential lack of learning that she fears accompanies a procedural focus against the motivational value of the data being used by scientists. In other words, her priority is student learning and community building, not accurate data for the larger GLOBE project. Ms. Cook’s commitment to teaching and to student understanding “outweighs” her commitment to GLOBE. In this case, she may have concluded that motivation without learning was not an adequate outcome and therefore decided to deviate from the curriculum in an effort to promote learning. This interpretation is consistent with the little attention that was given in class to entering the data onto the computer.

However, is there any strong evidence for this account? From her interviews, we can model Ms. Cook’s beliefs about learning. In the model there are three pathways to learning. First, there is learning by doing—by engaging in the activity of inquiry and hands-on experimentation. Second, she believes students learn through reflection about their own actions and the ways in which their understandings did or did not account for their results. Third, she believes that the students learn by discussing their ideas as a group—taking a position and trying to support that position with logic and evidence.

Given what we know about her beliefs about learning, strict adherence to the GLOBE protocols would seem to be consistent with her first path learning through hands-on experience. However, it conflicts with her second path, because in her opinion if students are simply following directions “they are not thinking.” For her third path to learning, learning through discussion and debate, we do not see an advantage or disadvantage for following the GLOBE protocols. Therefore, just looking at the teachers’ beliefs about learning does not seem to resolve the tension. Given her model of learning, two pathways out of three seem to still be open if she were to use the GLOBE protocols. Similarly, in examining her statements about the nature of science, her understanding of the science content, and her goals for the classroom, there was no clear pattern that would indicate the direction she would choose in resolving this dilemma.

We feel an exclusive focus on beliefs ignores the overall consistency seen in Ms. Cook’s interview about who she was and what she wanted for her students. In weighing her beliefs about learning against the structure and intent of the curriculum, we believe she relied on her own history and identity as a successful mathematics teacher—complete with all the values and practices that are associated with that identity. For example, her emphasis on invented strategies instead of following the GLOBE protocols is consistent with the pedagogical approach she used in her mathematics lessons. Further, in all three of our interviews, Ms. Cook never provided a statement that revealed her scientific epistemology. However, the approach she adopts and her emphasis on the process of inquiry as the goal for instruction

(and not the content of the science) is consistent with her statements that distance herself from the discipline of science and an identity as a science teacher.

Can we gain any insight into the relationship between identity and practice by examining her practice during this on-going dilemma? As we mentioned above, she often resolves this dilemma by deviating from the GLOBE protocols, but this is not always the case. Below we examine how and when Ms. Cook chooses to deviate from the GLOBE protocol on one occasion and triangulate this case with her self-reflections. On this day, Ms. Cook introduced an activity in which students were to experimentally investigate the different rates by which soil and water change temperature.

Ms. Cook introduced the lesson by stating that it was going to be a “fun” day, and they were going to do an activity on changes in temperature. She began by having the students imagine that they are spending the day at the beach focusing them in on how the sand feels on their feet during the day, how the water feels, and how the sand and water feels at night. This was not part of the protocol provided by GLOBE but something Ms. Cook added, presumably to connect the day’s topic to the students’ personal experiences.

During this introduction, Ms. Cook is animated walking back and forth in the front of the room, using multiple hand gestures, and varying the volume and pitch of her talk. She is at times almost playful. For example, at one point she animated her story, “And, you have to walk on the sand like this and it, it gets wet. You can run down to the water, put your towel down on the, on the, on the sand so that . . . it doesn’t hurt your feet.” While saying this, Ms. Cook acted out running across the sand and putting a towel down on the ground.

When her introduction ends and she returns to the GLOBE curriculum by providing directions for the experiment, Ms. Cook’s talk and interaction changes in noticeable ways. First, her lighthearted tone changes to a much more serious tone of voice (which is more monotone). For example, Ms. Cook states flatly,

You’re going to have to stick that [a thermometer] eight centimeters below the surface.
You’re going to have to stick another thermometer one centimeter below the surface, and another one you’re going to have to suspend it somehow one centimeter above the surface.

There is no discussion of why they are taking these three measurements every 2 min, why these particular depths, or how this will help answer their question about the changes in temperature at their imagined beach.

Even here, as Ms. Cook began to orient the students to following the protocol, she seems to waver. She spontaneously granted the students some additional agency and re-inserted some flexibility into the protocol, saying:

I’m not going to give you directions like, “Okay, tape it to a stick and stick it in there or, you know.” Uh, you have to kind of figure out how you’re going to do it. Uh, it’s probably going to be different for the water and the soil, because in the soil, maybe if you put it in, I don’t know if it’s going to fall through or not. You might have to somehow secure it. Okay. But you . . . you’re group is going to have to decide how to do that.

Once they had moved to the protocol, there was also a change in the roles that she took on and what was expected of the students. While deviating from the protocol, students were invited to discuss the temperature at the beach, student contributions were encouraged, and side conversations were allowed. However, when presenting the directions, Ms. Cook waited until students were sitting quietly before continuing to talk. Students were not invited to comment or question the directions. Additionally, Ms. Cook seemed to adopt a more authoritative and evaluative role when she engaged small groups of students and attempted

to get them to follow the protocol. For example at one point she said, “Okay. I need you to understand something. . . . Come over here, please. [This is the] second time I’ve asked you. I want you to stay over here. As a matter of fact, come right by me.” Our point is not that this style of classroom management is wrong or inappropriate at this moment, only that it was a marked shift away from the types of interactions that were happening a moment before.

We wish to point out two things about this interaction. First, we argue that in the oscillations between her adherence to the prescribed curriculum and her deviations and additions to it, one can see the emergence of a dilemma in Ms. Cook’s practice. Second, as her practice oscillates so does her affect. In the introduction and at times when she is deviating from the protocols she is animated and playful. When she is giving directives and helping students perform the protocol she is more subdued and more evaluative. We believe that this change in affect is a window onto the relationship between her identity and practice (a window that she is likely conscious of as well). When her activities are aligned with the type of teacher she thinks she is she is more likely to be happy and animated. When she acts in ways that are not aligned with her identity she is less so. However, there are oscillations and a dilemma precisely because she does not have one, coherent, stable identity. Instead, there are multiple ways that she can construct her identity in this moment in relation to her multiple goals and range of teaching practices.

Ms. Whyte’s Teaching Dilemma

Ms. Whyte also faced teaching dilemmas during GLOBE implementation. For her there is a conflict between her beliefs about the nature of science and her beliefs about how students learn science. There is also a conflict between her understanding of the implementation of GLOBE and her beliefs about the nature of learning and instructional goals. Although Ms. Whyte felt that social activism, active student engagement, and deep understandings of scientific concepts were important, her teaching practices emphasized following the directions of protocols accurately. On the one hand, she thinks that students need to actively engage in the lessons and with each other. On the other hand, her empiricist views about the nature of science lead her to take a very active role in structuring their investigations and to establish an emphasis on following the protocols as they are described in the curriculum, “as if lightning would strike you dead,” if you did not follow the directions. Interestingly, during the course of our interviews she becomes acutely aware of this conflict and commented, “rather than encouraging students to find their own answers and struggle with not knowing and trying to figure things out, I have a great tendency to want to impress them by how much I know. . . . And I don’t like that in myself, but I do it.”

We argue that it is Ms. Whyte’s identity as a science teacher that is the key to understanding these teaching dilemmas. For example, her history of volunteering for professional scientific studies seems to influence her focus on accuracy of data, even when this conflicts with her views of teaching and learning. Based on her statements during the interviews, we constructed a model of her beliefs about how students learn. Ms. Whyte’s model contains two paths to student learning. The first is through her, where she learns the material and then, teaches it, “to the students at a level we could all deal with.” The second path is through the activities, but only if the experimental protocols are followed precisely.

While Ms. Whyte felt she learned a great deal in the professional development activities, she also mentioned that she often felt out of her depth with the material. Since, she was not familiar with the content she felt she could not adequately mediate the students’ activity. To some degree this further explains why she relied so heavily on the students following the protocols exactly as the directions specified. Given her belief system, if students did,

they would necessarily empirically produce results that would settle their questions. It is important to note here that her instructional objectives (to the degree she articulated them) were for the students to know the science concepts. Unlike Ms. Cook, she never mentioned the process of inquiry as a high priority goal. This also helps to explain why she may have resorted to telling the students the answers when she knew them, even though this violated her own beliefs about how students learn, and why she may have skipped several science activities at the end of the semester. This disconnection coupled with frustrations with the school administration (discussed below) may have resulted in the lessons being reduced to a set of protocols with little authentic “inquiry.” For space considerations, we will not present an in-depth video analysis of Ms. Whyte’s teaching dilemma. However, it is worth noting that by the end of the GLOBE curriculum Ms. Whyte, like Ms. Cook, was showing signs of frustration, including canceling protocols and asking the researchers not to videotape her class on certain days.

Institutional Dilemmas

Finally, we believe that each teacher’s identity was a relevant factor in how they negotiated their role within their institution and this negotiation had a direct impact on their daily practice. Shortly before this study, a new principal was hired at Ms. Cook’s and Ms. Whyte’s school and the teachers told us the tone of the school changed. The new principal rearranged students into new ability-based classes midyear. An action that dramatically impacted teachers and students. These classes tracked the students into either high performing or low performing groups. She also mandated that all instruction needed to be standards based. Just after the changes, our study began.

The teachers were eager to talk about the impacts of all the changes on their teaching and their students. Ms. Cook talked about the changes in her teaching. She describes the times when she first became a teacher when she says, “Risk taking and trying new things were really very much supported and encouraged. I was always out on the edge of trying new things. And that is totally the opposite of the way it is now” (Conversation #1, 11-14-01). And then after her new principal made changes, Ms. Cook mentions, “I guess I have changed so much as a teacher. I am afraid of a lot of stuff now and I used to be such a risk taker. Slowly I am coming out of that but I was really put down big time. And I feel that I am kind of scared” (Conversation #2 12-18-01).

One example of where Ms. Cook was “afraid” was when she backed down from inviting an environmental activist group from visiting her class because their involvement in some legal cases was perceived to be somewhat controversial. She recalled:

Not calling Local Environmental Justice.⁴ Not to have, you know, the parents of 12 kids that died, all from cancer in the same neighborhood near the school, come into my classroom and talk to my kids. Because I’m afraid my principal might not want me to and she’s not gonna like it. . . . I have fear in me this year, which I’ve never had in my whole teaching career. (Interview 3A, 6/30/01)

This issue was close to the core of who she said she was

I think one really big thing that we do is when we see a need in our community, we get together and we do something about it. And, I think that really brings about some kind of change in the classroom where we see like—we don’t see ourselves as me, this is my

⁴ Pseudonym of a local environmental organization that combats environmental racism.

identity; this is who I am. But we see that oh, there's somebody in my community or somebody in my world that needs help. And, I'm gonna do something to help. And, I think that makes a really big difference, I really do. (Interview 1A, 5/30/01)

Ms. Cook speaks of her timidity but she is also defiant. She talks about how the material will change and she can no longer ask the kids what they want to learn, she will not change her method, "I mean, I have to do these standards. I'm still going to teach the way that I think is best, even though the material might be a little bit different than what I used to do" (Interview 3A, 6/30/02).

Ms. Whyte's relationship with the institution as represented by the principal is also not a positive one. Ms. Whyte feels like she is in a situation that is not changeable. When the classes were rearranged, Ms. Whyte was forced to do something that she felt was not good teaching. She explains the constraints she faced.

Because I had a whole new class of students, I couldn't go on from where I was, and yet a third of them had been here before, so I couldn't start over. It made no sense. So I dropped it entirely, which is not good teaching, I know that. And just, it was the situation we had to deal with. (Interview 1B, 5/30/01)

This relationship even affected the choice of GLOBE activities Ms. Whyte felt like they could do. She was not allowed to dig for any of the soil protocols or soil studies, so she did not. Ms. Cook ignored that decree and walked her kids across the street to a local park to dig and take samples of the soil.

In addition, because of what Ms. Whyte sees as the limitations of GLOBE and her institutional constraints she estimated that only one third of her students were successful. She comments:

[Based on] the responses that they make to questions I ask them or comments I hear them make to each other, or when they get something new to do, whether they seem to have a kind of level of background to deal with it. Two thirds of them don't. (Interview 2A, 6/13/01)

Both teachers originally volunteered to learn about and implement GLOBE activities, and both teachers had frustrations with their school setting⁵; however, their connections to the curriculum and teaching practices differed. Ms. Cook was connected and excited with aspects of GLOBE. Furthermore, she continued to co-inquire, even when met with obstacles. Ms. Whyte, on the other hand, seemed to grow more and more disconnected with curriculum.

CONCLUSION

This paper has compared two teachers implementing the inquiry-based environmental science curriculum titled, Global Learning and Observations to Benefit the Environment (GLOBE) after attending the same training session. In a previous paper, Enyedy and Goldberg (2004) document the divergent classroom practices of these two teachers and the subsequent learning outcomes for the students. We argue, however, that a focus on practice and outcomes is an important, but limited aspect of what we, as a field, need to consider when attempting to understand the complexities of teaching and learning. Therefore, we continue to expand our understanding of two science classrooms as we examine the teachers' multiple identities in relation to their implementation of a science curriculum.

⁵ By the end of the school year, both teachers sought and accepted employment at other schools.

Our analysis also raises some interesting questions about relationship between science content knowledge, pedagogical content knowledge, general pedagogical knowledge, and identity. It seems likely that Ms. Cook would not, based on her lack of science credentials, be deemed to be “highly qualified” as defined by law. However, we think this focus on the number of science courses taken in college or the teacher’s performance on a test of her science content knowledge creates too narrow a perspective. We do agree that content knowledge is important. Further, we recognize that without an understanding of the concepts it is more difficult to develop the pedagogical content knowledge (PCK) around how students are thinking and the best moves to make in order to shift that thinking. However, in this case Ms. Cook’s strong commitment to student centered, inquiry learning (what we refer to as her pedagogical knowledge) seems to mitigate and perhaps overcompensate for what could be framed as a deficit.

We believe that through her practices she establishes a classroom community that reframes her lack of content knowledge in a positive way. By positioning herself as a co-inquirer with her students, she creates a community that is pursuing real questions to which no one in the classroom has the answer. This also changes what the nature of what PCK means in this context. Since the object of her classroom becomes how to find answers to the full range of questions, the class has about it’s local environment, inquiry skills become at least as important as the particular answers they help generate. In this way Ms. Cook’s strong understanding of how to foster student-centered inquiry, which she has long practiced in her math lessons, becomes the foundation of her PCK in science.

We believe this study also has methodological implications. For our own understanding of what happened in these classrooms and why, it was critical to incorporate analyses from both interviews and videotapes of classroom interaction. We believe that the analysis would be sorely lacking without both components. Neither analysis of classroom interaction nor interviews with teachers gives a complete picture of a teacher’s identity. In particular, interviews by themselves, do a poor job at capturing how one is positioned with respect to one’s identity and how identities in particular moments are made relevant by interaction. Furthermore, video clips in this case helped the teachers explore their own beliefs and values about learning, science, and teaching. Thus, the videos were an invaluable tool within the interviews because they helped teachers make connections and contradictions visible to teachers and made parts of their identity available for reflection to orient and spark change.

Understanding identity is complex and future studies may help us better understand how to uncover some of the confusion about this complex concept. In these case studies, the teachers’ stories tell us that identity, including but not limited to beliefs, goals, and knowledge, does matter when discussing and analyzing practice. Differences in the ways these two teachers view the classroom and their role are consistent with the observed differences in their practice. And the contrasting views of the process of inquiry are also consistent with differences in practice. However, we argue that both teachers are making intelligent local adaptations of the curriculum given their current understandings and situation. Throughout our study, the ways teachers were struggling with multiple conflicting beliefs goals and knowledge became apparent to the research team and also the teachers themselves. As we widened the field of study, the ways in which the context (e.g., social, historical, and institutional constraints) affected the process also added to the teachers’ stories. Thus, an enhanced or expanded view of who these teachers are, how they describe themselves in the changing institutional context, and what they’re able to do emerged in this study.

Repeating from an interview excerpt above, Ms. Whyte commented that “I don’t like that in myself, but I do it. When I’m more conscious rather than less conscious, I don’t do it.” It is extremely difficult (or impossible) to constantly “be conscious” of an attitude while teaching, even if we are aware of a teaching practice that we do not like. One important

implication of this study is to consider practice and identity simultaneously, as they are intertwined. At times, if a teacher is aware of their identity as a science teacher and how it is linked to their practice, they will have more “control” over changing or adapting a current teaching practice and be able to use their identities as a compass to navigate teaching dilemmas.

This paper was supported in part by a grant from the National Science Foundation, GEO-9870081, and a gift from the Microsoft Corporation. The claims in this article are ours alone and do not reflect the positions of the sponsors or any of their officers. We would like to thank Frederick Erickson, Candy Goodwin, and Mike Rose for their feedback on earlier drafts of this paper. Their comments and suggestions improved both the depth of the analyses and the clarity of the writing. Finally, this work would not have been possible without the collaboration of the two teachers who allowed us to document their practice and help us understand the complexity of their daily work.

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