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AUTHOR	Weiss, Tarin H.; Feldman, Allan; Pedevillano, Dolly E.; Capobianco, Brenda
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ABSTRACT

This study, which occurred within an introductory-level biology course, examined how participation in a large-scale reform effort (the Collaborative) affected a science professor's conceptions of teaching, teachers, and reform. The Collaborative brought together a community of people who were part of a culture and co-created a culture of reform-mindedness. It taught participants to view the classroom environment as a place where learning was cooperative, active, and negotiated. The study examined how the professor's teaching identity was modified and created by the reform effort as she mediated her participation. Data collection involved interviews/correspondence with four students and the professor, classroom observations, and field notes. Overall, although the professor was inclined to try reformist strategies in her classroom, the project failed to create pedagogical dissonance, resulting in her inability and lack of desire to fully accommodate reformist pedagogy. Though she aligned herself with other participants motivated to improve their practice, she was not dissatisfied with her pedagogy at the outset. She became increasingly frustrated with the misalignment of her needs and interests with those of the project. She had a highly developed identity as a scientist and educator and valued her role as an educator. (Contains 27 references.) (SM)

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Tarin H. Weiss, Allan Feldman, Dolly E. Pedevillano, Brenda Capobianco
University of Massachusetts at Amherst

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Abstract

In this study, part of a larger project [SGER] investigating k16 teachers and science reform, we seek to understand how a science professor's participation in a large-scale reform effort affects her conceptions of teaching, teachers, and reform. The topic in this study concerned how the professor's teaching identity was modified and created by the reform effort as she mediated her participation. A multiple-method approach utilizing (a) semi-structured interviews/correspondences with four students and the professor, (b) classroom observations, and (c) field notes, comprised the data collection. Results indicated that, although she is inclined to "try out" reformist strategies in her classroom, the project failed to create pedagogical dissonance thus leading to her inability and lack of desire to fully accommodate a reformist pedagogy.

Introduction

The past half-century has seen a multitude of efforts to improve science teaching in the US. Yet, based on state, national, and international examinations, reform efforts have yet to influence teacher practice enough to reach the national goal of science for all. In this project, our goal has been to understand what happens when K16 teachers participate in a large-scale reform effort. We seek to understand how their participation in a science education reform effort affects their conceptions of teaching and teachers, and their development as teachers. We consider factors such as the participants' knowledge, beliefs and experiences; and institutional ideologies, structures, policies and practices. In this paper we report on the findings while paying particular attention to the transformation of our research paradigm to increase both the validity of our findings and their value to educators.

In this study, we posit that the curricular and pedagogical reform efforts of a group can lead to the creation of a culture in which the identities of its participants are, to varying degrees, altered. The values, beliefs, and behaviors of participants offer insights into the potency of the reform effort's goals. This paper begins the work of describing the identity of a science professor participating in the created culture of a large science and teacher education reform effort (the Collaborative). Specifically, the study characterizes the professor's experience utilizing the assumptions that her participation lead to the creation or modification of her identity (as an educator) that affects how she thinks about teachers and teaching and her beliefs and/or actions.

Conceptual Framework

In our original conceptualization, we drew upon four bodies of research on teaching and teacher education. The teacher knowledge perspective (e.g., Shulman, 1986) suggests that teacher expertise is related to what teachers know. The teacher reasoning perspective (e.g., Fenstermacher, 1986; Schön, 1983) assumes that teachers are knowledgeable professionals who reflect on their practice and make deliberate decisions about their goals and actions. Teaching is seen from the sociocultural perspective as a contextualized activity in which teachers' beliefs, goals, behaviors, and their sociocultural milieu are assumed to interact dialectically (e.g., Tobin & McRobbie, 1996; Clandinin & Connelly, 1992). The teaching as a way of being perspective recognizes that teachers are people in the role of teacher, who act as teachers, and teach in educational situations. It is through their being in these situations, with their web-like structures that extend not only through time and space, but also across human relations, that teachers come to understand others through a hermeneutic interpretation of their interactions (Feldman, 1997; Stengel, 1996).

Our intent was to combine views from these perspectives into multifaceted constructions of participants' knowledge, reasoning, sociocultural interactions, and ways of being. As we began to do this through data collection and analysis, we developed a theoretical framework that ties together the sociocultural and way of being perspectives by focusing on culture and identity.

In our model, culture consists of the "beliefs, behaviors, and artifacts of a group of individuals that recognizes itself as a unique community (Schwartz, 1996, 9)." In our paper we show how the Collaborative exhibits the characteristics of culture (Schwartz, 1996) within which students, K12 teachers, and college teachers can participate. Their interactions as part of the culture shapes their identities (Helms, 1998; Blum, 1999). We use identity to refer to the individual human being that is the living construct of one's experience (Helms, 1998; Reber, 1995). In Helms' model the sense of self or identity has four dimensions: actions, values and beliefs, others' expectations, and a sense of the future (1998, 829). To Helms, values and beliefs are at the center of one's sense of self. They are influenced by and influence one's actions and others' expectations. This dynamic trio interacts dialectically with a vision of oneself in the future.

While we found Helms' model useful for thinking about an individual teacher's identity, it lacks a clear connection to culture. Blum (1999) makes this connection in his model of ethnic identity. Thickly ethnic people live and breathe their ethnicity. They often live in mono-ethnic neighborhoods, have a family life permeated with ethnicity-based rituals, and have friends who are almost solely from that group. Thinly ethnic people partake of some aspects of their ethnic culture but often do not live among members of their ethnic group. Identity ethnicity is primarily a label with little or no cultural content.

Our model uses the ideas of culture, identity and way of being to understand how people are affected by participation in a large-scale reform effort such as the Collaborative. An education reform effort is seen as a way to modify or create culture. When people participate in this new or modified culture it changes their identity or way of being in relation to that culture.

Theoretical Assumptions

This study makes three important assumptions in its effort to characterize a participant's interaction in a large-scale science, math, engineering and technology (SMET) college-level reform effort (the Collaborative). First, it presupposes that the community of individuals (approximately 200) brought together by this grant is part of the Collaborative's culture of reform-mindedness. Second, characterization of the participants' interaction and involvement in the culture is necessary in order to describe ways that the project impacted teacher practice. Further, it posits that a participant's teaching identity is affected by and affects the culture of the Collaborative. Exploring the multidimensional nature of the teacher's identity offers understanding and implications to the effort of reforming undergraduate science education. More thorough explanations of these assumptions follow.

The Collaborative brought together a community of individuals that are part of a culture and co-created a culture of reformed-mindedness. This community is accepted to be, as Blum (1999) states, "a grouping of persons with some degree of organization or a shared, recognized status" that "is taken to realize some positive value, and not simply to exist as social entity or classificatory group" (p. 135). Such a community exists with a "collective intentionality" through which members have "the capacity to share intentional states such as beliefs, desires, and intentions" (Feldman, 1997, p. 766, from Searle, 1995). The notion of collective intentionality assists us in considering the cornerstone thinking of the Collaborative, that is, a culture of changing and improving science education. Here culture is described using both of Fetterman's (1989) definitions of the ideas, beliefs, and knowledge characterizing a group of people as well as the observable behaviors (patterns, customs, ways of life) of a group. A science education reform culture exists already in the world and the Collaborative offers a manifestation of its existence.

The Collaborative based its efforts firmly in the educational research literature supporting a contemporary reformist epistemology to increase students conceptual understanding and interest and to foster a higher rate of involvement of marginalized groups in science and math (Khan, Clement, Leckie, & Yuretich, 2000). The main venue for reform at the higher

education level is through the revision of undergraduate science and math courses at participating universities and colleges. Course revision requires offering new ways for college professors to envision teaching their courses and a shift from traditional methods. D' Avanza (1998), a co-principal investigator of the project, illustrates the Collaborative's teaching and learning culture as student-centered, inquiry-based, focused on the nature of science and science/math skill development, and one that promotes an interest in learning and teaching (Table 1). The Collaborative taught participants to conceive of the classroom environment as less of a place to transmit knowledge to passive receptive students and more as a place where learning is cooperative, active and negotiated. It urged participants to consider the "less-is-more" approach when re-evaluating important content.

Table 1: What does a [Collaborative] course look like? Attributes of students and faculty. (from D'Avanza, 1998)

1. The Learning Community in the Classroom
Students engage in self-teaching.
Faculty recognize that a major aspect of his/her role is to help students learn and not to "teach" them.

2. Fostering Higher Order Thinking
Students develop critical thinking skills.
Faculty can clearly explain the critical thinking skills he/she is trying to develop in the course and can explicitly describe the activities that are designed to improve those skills.

3. An Appreciation for the Nature of Science
Students develop improved understanding of the scientific process.
Faculty believe that an important goal of the course in helping students understand what science is and what scientists do.

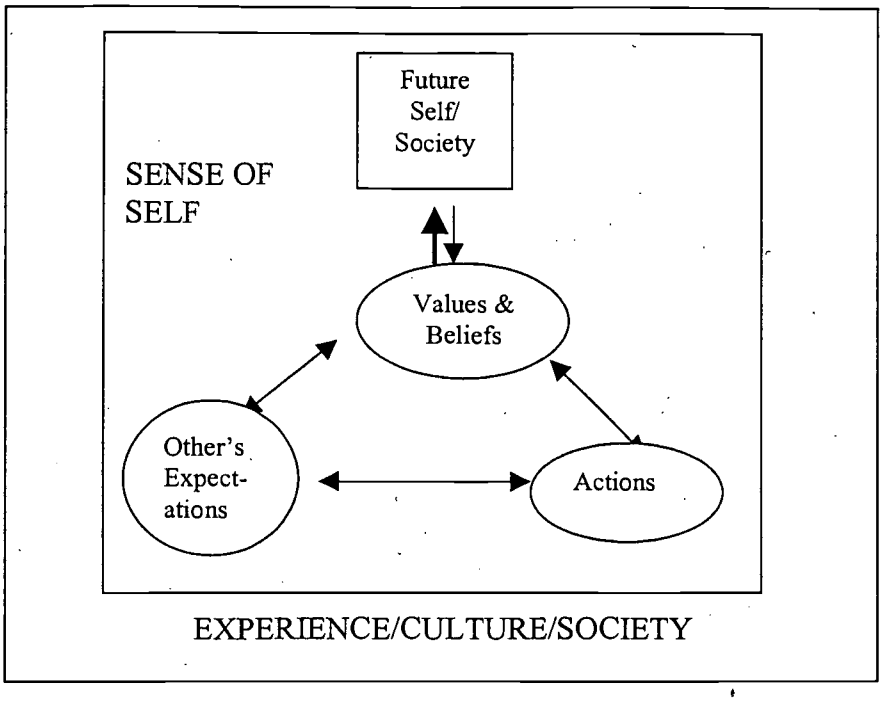
4. Developing Science and Math Skills
Students show gains and interest in math plus reading, writing, and talking about science.
Faculty can explain the skills they emphasize in the course and explicitly how they help students develop these skills.

5. Developing an Interest in Learning and Teaching
Students become more interested in learning and teaching.
Faculty are self-reflective about their teaching and show interest in talking with their students about teaching and learning.

In regards to the second assumption, our efforts to understand how a participant's identity interacted with the Collaborative's culture were aided by Blum's definitions (1999) that characterize an individual as having either thick identity, thin identity, or identity ethnicity with respect to a particular culture (described earlier). Blum's framework offers a useful perspective to our search for meaning in the participant's involvement in the project.

Finally, the assumption is made that participation in Collaborative leads to the modification of the participant's identity as a teacher in the world. More specifically, participants are influenced in ways that affect what they think and believe about teachers and teaching and how they behave as educators. Of course, such influences may or may not be in line with the goals and culture of Collaborative. The reformed culture acts on a teacher's identity and at the same time may be restrained by the teacher's existing sense of self. The study accepts the position offered by Helms (1998) that a science teacher's identity is deeply rooted in her personal relationship to science and how she sees herself in the world. Thus, identity "comes not just from what a person does, or his or her affiliations, but also from what a person believes, what a person values, and what a person wants to become" (p. 812). Helms believes that an understanding about the teacher's sense of self can lead to understanding about her "curricular choices, pedagogy, and career trajectory" (p.832). Helms' conceptual model (Figure 1) is used as a framework upon which to situate the words and actions of the professor under study. Using this framework guides our understanding of how she makes sense of the culture of the Collaborative.

Figure 1: Helms' Model of Teacher Identity (1998)



Context

The setting is one of 15 Collaboratives for Excellence in Teacher Preparation funded by the National Science Foundation to prepare more science teachers, and for them to be more ethnically diverse and better prepared to teach science in elementary and secondary schools. The Collaborative that was the setting of our study includes the State University, four private liberal arts colleges, three community colleges, and seven school districts.

The study described in this paper was conducted in an introductory-level biology course. The professor under study, Professor Schultz, is a veteran teacher of 25 years who was recently recognized as a Distinguished Teaching Professor by the University. She has published several articles on teaching in biological journals. As an associate professor, her faculty responsibilities include teaching (65%), extension work (15%), and research (20%).

Professor Schultz's class met for an hour and fifteen minutes twice a week. Although individual classes varied greatly, in general classes began with a mini-review session, presentation of visual aids (books, nature samples, related artifacts), a student report, and approximately forty-five minutes of interactive lecture.

The course covers 14 topics related to biology. Students read the required text authored by the professor, newspaper/magazine articles, and some primary literature papers. Student work consisted of papers, five quizzes and a final exam, two verbal reports, and completion of two group reports. Students utilized the Internet frequently. Five labs and five small group discussions, illustrating the critical concepts of the content and related social issues, engaged students in a variety of collaborative experiences.

Nine women and eleven men, ranging from freshman to senior, were enrolled in the course. Academic majors of the students varied greatly (education, communication, engineering, business, history, English, biology, holistic health, anthropology, journalism, political science, and undeclared). Seventeen students were Caucasian and 3 were students of color.

Methods

The methods chosen for this study were those of case study research (Yin, 1989) and ethnography (Erickson, 1986) including the use of semi-structured interviews, classroom observations, student and teacher surveys, and the collection of documents. Observations and interviews were audiotaped and then transcribed for analysis. Data was collected during the Spring 2000 semester.

Two 45-minute interviews were conducted with the professor. Four students (3 females, 1 male) volunteered for 45-minute interviews. The interviews served to "elicit the participant's worldview" by "[posing] open-ended questions followed by requests for elaboration" (Rossman & Rallis, 1998, p. 124). The organization of the interviews followed an open-ended and flexible interview protocol. The protocol utilized concrete lead off questions/scenarios that elicited participants' implicit theories guiding action with follow up questions designed to help them generalize and theorize about their answers. All interviews were followed up with 2-3 email correspondences for further clarification of participant statements and to elicit additional information.

Fifteen classroom observations were completed that included informal conversations with the professor regarding her thoughts and actions. Field notes during observations consisted of narrative transcripts of the activity and discourse during class. A flexible observation schedule was utilized. All field and observational notes were transcribed.

Data analysis utilized the methods of grounded theory, consisting of constant comparison analysis and triangulation (Cronin-Jones, 1991; Glaser & Strauss, 1967; Strauss & Corbin, 1990) and the construction of understanding through the use of long and serious conversations as research (Feldman, 1999). Data was analyzed throughout the study for regularities, patterns and assertions (statements describing patterns). The data was continuously re-organized and analyzed as new data was collected. Research meetings, during which data and concepts were discussed with other project researchers, guided the data analysis.

The data analysis procedure began with the first author's development of coding categories through an iterative process comparing all data sources as they were collected. Theoretical perspectives emerged concerning Professor Schultz's engagement with the Collaborative leading to questions concerning the personal, structural, and institutional conditions constraining her interest and participation. Through monthly meetings with the project's researchers, a sociocultural perspective developed about all the project's studies. This perspective focused the characterization of our findings and lead us to ask questions and search for frameworks and models that would illuminate our emerging interest in the interplay of the Collaborative's culture and the participants' identities.

Findings

This study, as originally conceived, sought to identify and understand the effects of participation in the Collaborative. By conceiving of the study in this way, we found ourselves defaulting into a technical research orientation (Habermas, 1971) in which the Collaborative causes participants to change in some way. We rejected this approach early on for several reasons. First, it was not valid. Because of the diffuse nature of the reform effort, few of the participants were involved in the Collaborative in the same way. The resulting atomization of the population of participants into sample sizes of one or a few made it impossible to use a statistical approach to make generalizations from the sample to the population. More importantly, this orientation seeks to identify causes and effects rather than to make meaning of the situation, which was our goal. Finally, early on in our data collection and ongoing analysis, we began to see evidence that the way that participants self-identified in the Collaborative did not necessarily correspond to their roles or level of participation in the Collaborative. As a result we developed a theoretical framework in which an education reform effort, such as the Collaborative, can be thought of as a culture, and participation in that culture results in modifications in one's identity, which then affect beliefs and actions.

Involvement in the Culture

Data analysis reveals that the professor in this study can be considered a Collaborative member with "thin ethnicity." This, according to Blum (1999), means that she "partakes" of some aspects of the culture without living in it or attending its "school" with other members. Involvement in the culture is not "very salient in [her] daily existence." Participants with "thin Collaborative ethnicity" have attended the requisite workshops and followed the procedures to gain membership into the culture. They agree that students should learn in effective environments, but only partially embrace the Collaborative's interpretation of how educational reform should look. These members do not interact with the project at a high a level. Evidence for grouping the professor as described above is embedded in her interviews, classroom observations, and analysis of classroom materials as the following quotes illustrate.

> I have to tell you as a participant in [the Collaborative], my impression as a person sitting in the audience [is] if you're not doing these formal things, your teaching is bad. That is the impression they give me. And I'm sure it's the impressions of a lot of the other faculty and when you send those things out and nobody responds, I think people just are so turned off. Because, I don't know about the other people, but I know what I put into my teaching, and know what works and what doesn't work, and I'm always looking for new ideas- that's why I used the jigsaw, I said, "Oh, this is perfect, I'll try that." And you know what, I really liked how it worked and I'm going to do it again. And every time I talk to anybody who teaches, I'm always looking for stuff I can steal and use that would be good. But don't tell me that I have to be doing these things or I'm not doing good teaching...
>
> So, I really liked some of the speakers that came in from the outside and tried some things that I liked a lot. I wanted to hear what things they tried and what works and what doesn't work, and I did not want to be given a check sheet and told that if I'm not doing *this* and I really didn't want to be told that if I'm lecturing - I mean, it really got that I didn't want to come anymore.

In addition, she describes how she considered the Collaborative's professional development ideas more as enhancements to her teaching than a reform of her pedagogy.

> I think it might have been better, this is hindsight now, but if they had said, given us a sort of laundry list and talked a little bit about it, kinds of things to try, because I think we all don't want to have especially a course of just lecture, we all would like student interaction and student participation and stuff, there's no doubt about that. So, I would've gotten more out of it if they had said, here's a whole bunch of little things that you could try, and then have people come back, and in a group situation, have them talk about they tried it and what the plusses and minuses were. Because, you are giving up time, you are giving up content when you have to make those decisions, and maybe the benefits outweigh it, maybe it's worth it, if you can shorten what you're saying about stuff, let them read it, and if it's so good and the kids liked it so much. Rather than come in with the idea that, you know, you've got to reform your teaching and this is the only way to do it.

Categorizing Professor Schultz as a Collaborative member with "thin ethnicity" raises questions about her identity as an educator and how she mediated the Collaborative's influence on her sense of self. To begin addressing these issues, we consider identity through Helms' conceptual framework.

Professor Identity

Professor Schultz's teaching identity is characterized using the model of professional identity developed by Helms (1998). Excerpts from her interviews and informal discussions offer a glimpse into how her values and beliefs, actions, other's expectations, and future self/society constitute how she sees herself as a teacher and a person in the world. This glimpse offers us critical understandings about her involvement in the Collaborative.

Values & Beliefs

Through our interviews, Professor Schultz described her dedication to and enjoyment of her science and teaching position. She deeply values learning about teaching as well as her position, expertise, and knowledge. Further, she sees herself as an advocate for her subject and for women in the sciences in general and effectively acts on these beliefs. She describes epistemological and institutional impediments to allowing this class to becoming more student centered and inquiry-

based at this time, yet does not rule out it becoming more so in the future. Her descriptions align her with the cognitive apprenticeship notion of learning (Brown, Collins, & Duguid, 1989) and places great responsibility on her role as expert in the community. Interviews reveal Professor Schultz to be a highly confident educator and scientist who has seen the positive impacts of her work.

> I have a 65% teaching assignment, 15% extension, 20% research... But that's what I like to do. That's why I became a [biologist], it's the extension, applied research. The best thing about it is that it all comes together, the research I do is to solve problems I see in extension, the teaching I do prepares these people to go out in the world and then I get to stay in touch with my students because they come back or call me on the phone. It's lovely. It's just wonderful.
>
> You know, you got to do what you think is important, what you think you can do. I know what my strengths are; I know what I can do well.

Her students are appreciative recipients of her teaching/scientific knowledge.

> And I think she very skillfully brings out what we do know and she organizes it in a very coherent fashion. And in fact we do know a lot of this stuff, we've had it before, or it's something we've absorbed from the background but that she really helps to bring it to the forefront which I think works very well.
>
> Her interest in the subject is what really makes her a good instructor. She is passionate enough about her subject without being wrapped up in her own studies that she is effective. Her love for the subject is evident in the slides, videos, and the current issues she brings in to the classroom. Her interest in what the students have to say is genuine; she makes us feel as though we're the ones teaching ourselves, and she becomes a sort of extremely respected equal versus just another professor.

Professor Schultz also speaks of her belief that it is important for females to see women scientists – and here we see how she considers her work to be important from a social perspective. She goes on to speak about the difficulty of living a scientist's life and ponders its amenability to most people's lives. On the other hand, her love of the discipline seems to override such doubts.

> And that's one reason that I do a lot of teaching, because I like them to see women in science...
>
> But boy, it's tough, and it's getting worse. And I think the demands to be a faculty member in science, or to work in science, is 7 days a week - tremendous burnout. It just is not compatible with the kind of lives that people want to live... I have to think real hard about recommending that life to someone, and that makes me very sad, because I have always seen my role as attracting people to my discipline. And it's not just my discipline; I think science in general.
>
> I think many early undergrads have no idea what they want to do. I hope that I might spark that interest.

In the classroom, her ability to spark an interest in the subject is evident in the activity and comments of students during lecture and lab activities. For example, students were often heard exclaiming, "Wow. Cool.!", "Why is that?", "Ask her what's going on!" as they conducted lab activities. During interviews, all the students readily comment on her ability to motivate and interest them in the subject.

> Her enthusiasm for it is a big deal, I think. You can't help not like her or the class because she's really excited about everything. That's really important I think...I came into the class not being very interested at all and I just thought it's something new I could just learn about something I know nothing about. I am interested now. I am thinking more, like, I want a garden when I get older, how can I? How can I? You know this makes a lot of sense, I'll make sure to remember to spray no later than, and like things like that, so there's some relevance.

Because of her subject matter knowledge, enthusiasm for the subject, and teaching expertise, Professor Schultz sees herself as a guide, but not the "guide on the side" promoted by reform. For her, teaching and learning should be teacher-centered, with serious focus on guiding students' learning toward acceptable levels of comprehension. , "if I can help a student read a science article in the newspaper or a magazine and think they can understand it, I feel very happy". In many ways, she manifests the cognitive apprenticeship notion promoted by Brown, Collins, & Duguid (1989) out of Lave and Wenger's (1991) theory of situated learning. They call for allowing students to enter a community of practice as an apprentice and become

enculturated into the culture. In this way, students observe community members and practice appropriate language, questioning styles, and behavior. For example, Professor Schultz guides student inquiry in lab activities and successfully teaches them important appropriate principles through simple hands on activities focusing on observation and technique.

> I do think students benefit from seeing real experiments- where we don't know for sure what will happen... They benefit in seeing how an experiment is planned, how we decide how to take and record data, how we put in replications for statistical analysis. And simple things like keeping things clean and organized and ready for each step. Probably the most important thing they can learn is how to decide what question needs to be answered and what information is needed to answer that question. As always, I think this is a one-on-one teaching experience where a student gets to know a faculty member better- how they approach their work, how they feel about it.
>
> They cut fungal sclerotia (survival structures) off potatoes and put them on water agar and took them home to see what would happen. Mycelium grew out from that across the agar within 3-5 days. They were supposed to note what happened each day. We had a follow-up discussion on the 5th day when they brought the plates back, looked at the mycelium under a microscope and then, in a group, tried to write a definition of a fungus based on what they had observed and what we had talked about in class. I did this because it is a very difficult concept for students to understand that a fungus is just a mass of mycelium- no particular body like a plant or animal. I was pretty happy with how that worked. And I hope they'll look closely at their potatoes for sclerotia for the rest of their lives.

Counter to reform efforts, she does not quite agree that there is a benefit to student-initiated lab explorations. In fact, conducting "REAL" (her emphasis) research, even for undergraduate science majors, may be an inappropriate use of time because they do not yet have enough knowledge or experience (cognitive apprenticeship's *tools*) to be effective.

> To really do research, you need to know what questions to ask. And to do that, you have to really know your field- what we know, what we don't know, and what we can find out. The more courses an undergrad can take in their field, the better. Grad school classes are usually very specialized. Undergrads want to know as much as they can about as much as possible. Research should be on a small enough scale to let them see if they like it, to interact closely with a faculty member to learn good research techniques and approaches, and to not feel that they have to miss classes to accomplish it. I hope that makes some sense.

Finally, she discusses the institutional impediments that constrain her ability to reform her course. Yet, in the spirit of "always looking for something new to try", keeps herself open to potential for change toward a more student-centered inquiry in the future.

> This is the first year that I have taught the course T-Th with a longer block of time. I needed to get a sense of what they could do with the more formal lab exercises and discussions and how long those would take. I have some other ideas that I would like to try too. One of the problems is preparation of lab materials. There is no TA for the course. And in a course like this, there are students who are really out of it, no matter how hard I try. That's one of the challenges- the disparity in attendance, interest, and ability. I'm trying to balance the use of time for gaining some knowledge, understanding and interest in the subject vs. exploring on their own.

Actions

Professor Schultz acts on her values and beliefs about her position, knowledge, expertise, and enthusiasm for the discipline in a variety of ways. For one, she continually searches for new teaching ideas that would work with her students. She also takes actions in the classroom that create highly interactive lectures and hands-on guided observations of natural phenomena within a non-threatening learning environment. She mentors pre-service teachers privately and offers them an additional credit if they do some teaching in the course. Field trips and daily presentations of subject related samples and objects belay her breadth of interdisciplinary knowledge and desire to connect with and motivate her students. During interviews, she stressed the importance of downplaying her power, being fair, and making students feel that they can succeed. She explains how these beliefs play out when she interacts with students.

> I think one of the problems in these classrooms is, and it's not strictly sex-related, but it's power. And how professors intimidate students and they do it deliberately, and they make it a challenge to learn... And I never understood that, but

> that is a real negative factor in classrooms [...] That's why I give them a review sheet, I give them an answer sheet, I give them an old exam, because the goal's to learn it. And there's plenty to learn. The game isn't that you can pass a test with a trick question... And I eliminate all competition; because they can all have an A. And that way they'll work together, because the goal is to learn the stuff. I refuse to curve, I never have to. I always give them plenty of time, and if they've gone through the course they ought to be able to answer the questions.

Her students repeatedly commented on her ability to down play classroom power and how it fostered their motivation to learn.

> She's more like a peer than a professor. She doesn't have the really typical, " I've written a book, I've done this, I've done that. I'm on all these committees." She doesn't have that attitude which a lot of professors do. Which makes me more inclined to listen to her, to care about what she says, instead of just blowing her off and she's on her high horse.

> One of things I like about the class is that she's very encouraging. One of the things she keeps on saying is, "See you guys already know this."

Other's Expectations

Through the lens of this study, Professor Schultz's revelations about her frustrations with the expectations of her research colleagues and educational reform-minded colleagues place her in quite an enigmatic situation. She explains how her department chair doesn't value the practical nature of her research with the extension service or her long-time focus on teaching. At the same time, the Collaborative promotes time taken be a reflective educator and a continued focus on educational reform. It seems as though she is at the center of a tug-of-war between two epistemologically estranged forces.

> Do you think all these old guys in my department here - my colleagues - they all were here, they worked hard, and they got tenure, and they kept working and they got full professor. And now I have my department head telling me that - you know I've got a string of teaching awards like this, I've written 2 books, I've done all this instructional technology - and he tells me I've done, quote, "Nothing promotable."

> ... don't tell me that I have to be doing these things or I'm not doing good teaching. That's a very offensive approach. And the kind of person who will sign up for something like this, like me, is probably there because they are probably pretty good teachers, it's the ones who don't sign up that you have to worry about.

Future Self/Society

In the midst of these conflicts, Professor Schultz has a clear sense of her future as a researcher and educator. She describes the cyclical connection of the various aspects of her job and how they continue to connect for her personally and professionally. She will continue to pursue ventures and collaborations with professional organizations that "keep me going" and will not change her activities to appease her department head. An important goal of the future is her aim to make her students, especially elementary education majors, feel successful and scientifically literate.

> One thing I try to do is to show them that they actually know a lot of science and that it is as much a part of life as any other area. It always bothered me that people would more or less brag about their ignorance of science when they would be embarrassed to say the same thing about art or literature. Some basic knowledge of science is part of being an educated person. But many people have become intimidated and close their minds to it. I try to reopen them and help them see it every time they go to the grocery store or out for a walk.

> And I am especially anxious to find a way to get more people who want to be elementary teachers in my class. I think most of them are very afraid of science, and I would like to boost their confidence in their own abilities and also give them ideas about how easy it is to give science to their students. They don't have to know all the answers and they don't need complex equipment.

Embedded in these quotes is Professor Schultz's confidence about her place as a scientist and educator in the scientific community. In general, she wants science to be accessible, useful, and pragmatic both to consumers of her research and her students. She is not riled by new or personally conflicting ideas. She is a scientist and, as a result, is used to dealing

with multiple problems and hypotheses. She is confident that her knowledge and goals will continue to lead her to making personally and professionally edifying decisions about research and teaching.

Conclusion

The professor speaks candidly about her conflictive relationship with the Collaborative – one in which she shares its goal of improving practice yet balks at its methods and practical assumptions about her need for professional development. She aligns herself with other participants motivated to improve their practice. However, *she* was not at the outset dissatisfied with her pedagogy. Receiving the university's Distinguished Teaching Award validated her practical theories and paradigms (Feldman, 2000) that had evolved over 25 years of college teaching and scientific research and has given her a "hard won sense of expertise" (Helms, 1998, p. 832). The Collaborative's workshops, seminars, and discussions did not create pedagogical dissonance for her, thus, she engaged in the culture more to assimilate ideas and resources to enhance her teaching than to transform it. Additionally, because of the Collaborative's perspective that broad reform of college SMET teaching was necessary and the explicit ways in which it acted on that position, the professor became increasingly frustrated with the misalignment of her needs and interests and those of the project.

Further analysis of her "way of being" as a teacher (Feldman, 1997) aided in describing the reasoning and origins underlying her *thin identification* with the culture of the Collaborative. This was accomplished using Helms' (1998) framework for understanding a science teacher's identity and Feldman's (2000) model of practical conceptual change. Utilizing Helm's framework identified the critical components of the professor's teaching identity, namely, values and beliefs, actions, other's expectations, and future self/society. Thinking about her identity in this way offers a compelling slice into the professor as a teacher.

This analysis reveals that the professor had a highly developed identity as a scientist and educator. She greatly valued her role as an educator and it meshes with other components of her faculty responsibilities, namely, university extension work and applied research. She describes how her research solves the problems she encounters in extension work, and how her teaching prepares students to go out work in scientific discipline she esteems.

The power of her sense of balance and purpose as a teacher and scientist lays the foundation for the practical paradigms that guide her thinking and actions in the classroom. So much so, in fact, that she will not alter her focus on teaching to please the department head. She values collaboration and practical applications of knowledge over more esoteric purposes and methods of scientific research. And though she describes a hegemonic structure in her department that may devalue and dismiss her work she maintains outside professional contacts and develops strategies that edify her sense of self as a scientist and educator.

Her way of being as a teacher places a great mandate on her pedagogy. Making students feel successful in science and increasing their general scientific literacy guides her thinking and actions in the classroom. Because she is successful in science and is scientifically literate, she feels a great responsibility to "do" for the students. Her pedagogy embraces "teaching as telling" in many respects, because "that's how you talk to adults isn't it?" (professor quote). However, as mentioned above, her lectures are not pedantic. Loaded with hypothesis posing and questioning techniques, her interactive lectures operate at a very high level as teacher-guided discussions.

Here we see how her constructions of being as teacher, scientist and person in the world offer her meaning and relevance. Her notion of what gives her work and life meaning act as a practical paradigm (Feldman, 2000) that will not accommodate alternative ideas for how she should a) focus more on pure research, or b) strictly adhere to a reformed pedagogy. With respect to the latter, her focus on making students to feel successful in science and promotion of their scientific literacy is grounded in their acquisition and appropriate presentation of scientific knowledge based on her expectations. It is not

so much that she disagrees with the importance of engaging students in inquiry, it is more that, for these introductory-level students, she fails to see it as a fruitful endeavor.

We suggest that Professor Schultz's engagement with the collaboration both changed and validated her identity as a teacher. On the surface, she assimilated some new teaching strategies and accepted them as effective ways to promote learning. However, such change was always within her value and belief system of what is important to teach and how it should be taught – new strategies that promoted her teaching goals were accepted while others were disregarded. As a long-time member of a culture aimed at improving science education, she adheres to methods and strategies that have proven effective for students by her and her professional colleagues over the years. It's as if, to her, the Collaborative was a too radical faction of a culture to which she already belonged.

The Collaborative, at many levels, failed to understand the nature of Professor Schultz's pedagogical and epistemological commitments. It was unable to access her values and beliefs about teaching and learning and her sense of self as a science teacher and person in the world. As a result, she never experienced pedagogical dissonance (Feldman, 2000; Gess-Newsome, Southerland, Johnston, & Newberry, 2001). In fact, the Collaborative proceeded with her professional development as if she *had become* dissatisfied with her practice thus increasingly alienating her purpose for joining the project in the first place. Professor Schultz interacted with the project on her own terms, becoming more disenchanted over time with the initiative's inability to respect and understand her hard-won sense of the nature and purpose of science education. A lack of understanding of her context constrained the Collaborative's ability to impress upon her how and why she should change her teaching identity and strive to develop as a teacher in epistemologically new ways.

Implications

In this paper we show that our model of reform as culture acting on participants' identity and way of being adds value and validity to the way we understand large-scale education reform. In the study that presented here, we have used our model to understand why even when people are drawn to a reform effort because of the similarity between its goals and theirs, they ultimately decide to dissociate from it. By envisioning the reform process as the creation of culture, and teacher change as identity change, we expose what may be the largest impediment to teacher change: In current reform efforts we are not just asking teachers to change what they do; we are asking them to change who they are.

The study has generative implications for higher education science reform efforts. It demonstrates the need for such efforts to emphasize and make explicit the values and beliefs embedded in a participant's teaching identity (Helms, 1998) as a means to interpret the nature and degree of her/his cultural engagement (Blum, 1999) with the project. Related to that, our research suggests that in order to meaningfully engage professors in professional development, project activities should be explicitly situated in the participant's context of teaching and being a teacher (Feldman, 1997). One way this is possible is if reform advocates create dynamic relationships with participants that operate through collaborative meaning-making and mutual respect for each other's values and beliefs. Connected to our theoretical framework of ethnicity and identity, future research efforts will focus on the possibility and viability of developing such a relationship. Taking a sociocultural and feminist perspective, we will explore and describe how a professors within a reform effort reflect and act on data (in the form of student reflections) about their practice using the researcher as an intervention (critical friend). This next phase of our research positions us to better understand the conditions necessary for a professor in a reform effort to become dissatisfied with her/his practice and accommodate new practical theories that reflect the goals of science education reform.

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