

Wearing the Letter Jacket: Legitimate Participation in a Collaborative Science, Mathematics, Engineering, and Technology Education Reform Project

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This study examines one NSF-funded Collaborative for Excellence in Teacher Preparation and describes the complexities of such a science education reform effort. A theoretical model based in community, culture, and identity is used to address key questions: How did institutional ideologies, structures, policies, and practices influence the Collaborative's success? What unique problems were associated with the university and school partnership? How did K-12 teachers' participation affect their development and the success of the Collaborative? Findings indicate that though K-12 participants were deemed as "pedagogy experts" and shared the inquiry-based culture espoused in the Collaborative, they felt both as project insiders and outsiders. This was due to issues of status between university faculty and K-12 teachers; teachers' less-than-active role in the Collaborative; and the constraints and narrow focus that resulted from long-established institutional, social, and political structures and that marginalized, delegitimized, excluded, and proved unattractive to teachers.

The United States is nearly two decades into a period of continuous effort to reform science education. Although there have been intensive calls (American Association for the Advancement of Science [AAAS], 1989, 1993; National Commissions on Education, 1983; National Research Council [NRC], 1996; National Science Foundation [NSF], 1999) and significant efforts to bring instructional reform to science classrooms, there has been little improvement in the achievement and performance of American students. Nearly 40% of U.S. eighth graders score below a basic level in science, and only 32% score at or above the proficient level (National Center for Educational Statistics [NCES, 2002]). In addition, U.S. students continue to score lower than those from other industrialized nations on international comparisons (NCES, 1999, 2001).

There are several distinguishing characteristics of this reform effort. It relies on a constructivist educational philosophy; it promotes inquiry and student-centered instruction; and it aims for excellence for all children. Possibly, what sets the past 10 years of reform effort apart from all previous ones is the attempt to act systemically on educational systems through the creation

of collaboratives that include state and local educational authorities, universities and colleges, and industry. While the complexity of the American educational system argues for systemic efforts, the argument that they require the creation of collaboratives is less compelling. Therefore, a critical question embedded within the reform vision is, "What evidence exists that collaborations provide for the preparation of higher quality teachers and enhanced learning in the public schools?"

We have had the opportunity to research this question in our study of one of the Collaboratives for Excellence in Teacher Preparation (Collaborative) funded by NSF to prepare more science and mathematics teachers, increase the diversity of that population, and better prepare them to teach science and mathematics in elementary and secondary schools. The Collaborative that was the setting of our study includes a state university, four private liberal arts colleges, three community colleges, and seven school districts. There are several defining aspects of this Collaborative:

1. The education of new teachers is distributed among the collaborating institutions rather than being located in teacher education programs.

2. All students major in one of the academic disciplines because of state regulations and take a wide variety of science courses to fulfill general education requirements.

3. Few of the prospective secondary science teachers enter the colleges with that career in mind. The result is that there is no distinct program for prospective science teachers in any of the colleges. This led the Collaborative to concentrate its efforts on professional development of college faculty rather than on course improvement.

4. K-12 teachers acted as pedagogy experts to help college teachers learn new ways to teach.

In addition, the Collaborative was rich in untested and novel ideas. First, science content courses were taught in reform-minded ways in settings that traditionally do not focus on teacher education (e.g., a research university and elite liberal arts colleges). Undergraduates in academic courses explored constructivist learning and teaching approaches and incorporated them into teaching experiences in K-12 settings. Such understandings and practices are not traditionally explored with students until they are enrolled in preservice teacher education programs. Little is known about the ways student participation in such courses influences their conceptions of teachers, their understandings of constructivist practices, and their view of themselves as science educators.

Second, networks were established in the Collaborative between higher education faculty and public school educators. K-12 teachers were placed in the role of pedagogy experts. Rarely are such structures established, and little is known about how, and if, they work and how they influence the reform process.

Therefore, we used our proximity to the Collaborative as a way to investigate the complexities of participation in an educational collaborative. In particular, we explored the following questions:

- In what ways did institutional ideologies, structures, policies, and practices influence the Collaborative's success in reaching its goals?
- What unique problems were associated with the university and school partnership?
- How did K-12 teachers' participation in the Collaborative affect their development and the success of the Collaborative?

Conceptual Framework

Often, researchers explore such initiatives from a technical-causal model, in which individuals are put through a treatment to achieve a hoped-for change or

result. Other educational researchers (Anderson & Helms, 2001) have pointed to the need to examine reform efforts systemically to understand the pathways and impediments to successful reform. They pointed out that to investigate reform efforts effectively requires critical, systemic inquiry from several perspectives, as multiple factors and a combination of interrelated efforts can serve as pathways and/or obstacles to change in classroom practice (Anderson & Helms, 2001; Anderson & Mitchener, 1994). In particular, the existing beliefs of participants, as well as the context of the reform—its structure and socio-cultural-political dynamics—may serve to support or work against the change process (Anderson & Helms, 2001; Anderson & Mitchener, 1994; Borko & Putnam, 1996; Loucks-Horsley, Hewson, Love, & Stiles, 1998).

We began this study with the belief that a complex educational system, such as the Collaborative, should be examined from such a sociocultural perspective. Early in our data collection and ongoing analysis, we began to see evidence that the way 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, could be thought of as a culture within a community of practice, and participation in that culture results in modifications of one's identity, which then affects beliefs and actions.

Communities, Their Structures, and Legitimate Participation

A community is a social arena with limits defined by the capital—cultural, social, economic, and symbolic capital—that is valued and needed for individuals to legitimately participate within it (Bourdieu & Wacquant, 1992). The term implies “participation in an activity system about which participants share understanding concerning what they are doing and what that means in their lives and for their communities” (Lave & Wenger, 1991, p. 98). Importantly, recent discussions about engagement in communities of practice suggest that “engagement in social practice” with experts and novices within a community provides individuals with an open door to sources of knowledge and understanding and the development of membership and identity (Davis, 1999; Lave & Wenger, 1991)

Full participation in practice involves “*becoming* part of the community” and an “*increasing sense of identity as a master practitioner*” (italics are in the original; Lave & Wenger, 1991, p. 111). A master or mature practitioner in the science community includes

(a) being skilled and knowledgeable about activities, tasks, tools, and understandings valued within science; (b) interacting and contributing within the profession and being seen as a valued member and participant in the change and construction of new and evolving capital, values, structures, practices, and membership of the science community; and (c) knowing what constitutes the structures and everyday practices of science, including the tacit, implicit, indescribable competencies and unexamined ways of being a member (i. e., how individuals in the profession talk and about what; who is included and “belongs” in the community and who is excluded; how, when, and about what long-time members of the science community collaborate and disagree and what they enjoy, value, admire, reject, and ignore) (Davis, 1999).

Embedded in the legitimate participation concept is the idea that all community members interact and contribute as valued participants in the change and construction of new and evolving capital, values, and practices of the group. However, inequitable structures and power relations within a community can open, limit, or close legitimate participation to individuals or groups within it and, thus, influence the quantity and quality of capital acquired and the development of identity (Lave & Wenger, 1991). If access and/or participation are blocked, intentionally or otherwise, then individuals can be disempowered or marginalized within the community.

For example, researchers, historians, and philosophers—and the science community itself (AAAS, 1989, 1993; Davis, 1999, 2001; Harding, 1991; Oakes, 1990a, 1990b; Seymour & Hewitt, 1997)—have reported the exclusion of women and people of color from science activity. Historically, biased beliefs, sexism, racism, stereotyping, ideologies, inequitable social structures, policies, and practices within the science community have served to limit and/or exclude females’ and minorities’ participation in it. Research describes the disproportionately low participation rate of females and minorities (i. e., African Americans and Hispanics) in science, technology, engineering, and mathematics (STEM) courses, educational programs, and professional careers; the obstacles and pathways individuals encounter as they seek to participate legitimately in STEM; and the peripheral/outsider status of females, minorities, and those from low-economic circumstances and the insider/participant status of dominant groups.

Status issues can play a key role in educational reform because status can determine the kind of activity in which one is permitted to engage and the extent of one’s voice, decision-making, and power within educational and professional contexts. For example,

females, minority students, and those in low-economic settings, at both the elementary and secondary level, are often not provided with academic programs, opportunities, and support that would provide them with the necessary knowledge, skills, and credentials to pursue postsecondary science and mathematics study and careers (Oakes, 1990a, 1990b; Stanton-Salazar, Vasquez, & Mehan, 1995).

In addition, the science community often views science majors who pursue a career in science teaching as “science drop-outs” (Davis, 2001). Teaching as a career carries “less than” status, as it is often seen as “women’s work” (Liston & Zeichner, 1991). As a result, one’s value as “a productive and respected member of society drops precipitously” when one enters the teaching profession (p. 114).

Within the teaching field, higher status is given to those who educate the oldest, most advanced students; thus, university faculty and high school teachers hold more status than elementary teachers, a group comprised mostly of females (Bennett & LeCompte, 1990). Males dominate administrative positions and university faculty positions. In general, women and minorities in the teaching field hold less status than white men do.

Culture and Identity

Participants’ interactions as part of a culture shape their identities (Blum, 1999; Helms, 1998). 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, p. 9). In this article, we show how the Collaborative exhibits the characteristics of culture within which students, K-12 teachers, and college teachers can participate. We use *identity* to refer to the individual human being who 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. 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 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.

It may seem odd to characterize participation in a collaborative as a form of "ethnic identity." However, this is closely tied to the idea of teaching as a way of being (Feldman, 1997; Stengel, 1996). From this perspective teachers are seen as people in the role of teacher, who act as teachers, and who teach in educational situations. Through their being in these situations, with their web-like structures that extend not only through time and space but also across human relations, teachers come to understand others through a hermeneutic interpretation of their interactions (Feldman, 1997; Stengel, 1996). Therefore, how teachers identify as teachers is related to their way of being teachers. In addition, this model acknowledges that one's way of being a teacher is related to the position that one has in a community of practice. This led us to an in-depth exploration of the Collaborative's communities and the participation, beliefs, practices, and experiences of the learners, teachers, faculty, and principal investigators (PIs) that comprised it.

A Model to Understand Educational Reform

In the analysis that follows we use our model constructed from the ideas of community, culture, identity, and ways of being, and from the idea of legitimate participation. In our model we see an education reform collaborative as a way to modify or create culture. To do so, the people and institutions at the center of the collaborative attempt to create, combine, or modify communities so that they embody the culture of reform. When people participate in these cultures it changes their identity or way of being in relation to that culture. How and to what degree they change is dependent on their status and whether or not they participate legitimately in the community.

Describing a community and experiences in it from the standpoint of K-12 teachers, a traditionally nondominant group within the science community, can reveal underlying beliefs and practices within a Collaborative that otherwise may be hard to see. Through teachers' voices, we can show a perspective not often heard and make "the familiar different" (Delamont, 1989). Therefore, in this study, we explored our research questions through the words, experiences, and practices of science teachers participating in the Collaborative as pedagogy experts. In particular, we investigated the following questions: In what ways did institutional ideologies, structures, policies and practices influence the Collaborative's success in reaching its goals? What unique problems were associated with

the university and school partnership? How did K-12 teachers' participation in the Collaborative affect their development and the success of the Collaborative?

Methods

We derived our methods from ethnography and case study research, including the use of structured and semistructured interviews; observations of undergraduate Collaborative science courses, teacher education courses, and K-12 classrooms; student and teacher questionnaires and surveys; and the collection of documents. Interviews were audiotaped and then transcribed for analysis. Pseudonyms are used throughout the analysis to maintain the individual privacy of the informants.

To determine the patterns and themes, data were analyzed using case study methods (as in Yin, 1989); qualitative data was coded as described by Miles and Huberman (1994); and domain, taxonomic, and componential analysis were completed to determine critical patterns and themes (Spradley, 1979, 1980). Data sources were compared through the process of triangulation. The analyses included particular description in the form of vignettes, field notes, and direct quotes, general description in the form of taxonomies and charts, and interpretive commentary to provide explanation and connections within the analysis (Erickson, 1986).

Participants

Participants were (a) undergraduates enrolled in Collaborative science courses, (b) students enrolled in Collaborative teacher education courses included in the early childhood, elementary, and secondary programs, and (c) in-service teachers participating in the Collaborative. Random sampling was used to select participants from each group. In addition, purposeful sampling (McMillan & Schumacher, 1997) was used to select participants representative of groups traditionally underrepresented in STEM disciplines (females and minorities); those who, by reputation, were identified as using Collaborative teaching approaches, and those who had taken a Collaborative course in science and who had enrolled in a Collaborative science methods course. The study included 17 teachers: 10 females and 7 males, 1 Latino and 16 Whites, 8 elementary teachers, 6 teachers at the middle level, and 3 at the high school (see appendix). Pseudonyms are used for individuals, programs, and institutions throughout this article.

A Brief History of the Collaborative

The Collaborative was one of more than 15 funded by the National Science Foundation as part of the

Collaboratives for Excellence in Teacher Preparation (CETP) program of the Division of Undergraduate Education (DUE). CETP was one of the first DUE programs to focus on teacher preparation. (Before the start of the program in the early 1990s, DUE focused almost exclusively on postsecondary education in the STEM academic disciplines). The intent of the program was to create collaborative networks among the academic disciplines, teacher education programs, school districts, and industry to improve undergraduate education in the STEM disciplines to better prepare prospective teachers in mathematics and science. NSF also had the goal of increasing the supply and diversity of math and science teachers as a result of improving their undergraduate preparation in STEM fields.

The Collaborative in this study was a project of a STEM education institute that was established in 1995 to improve K-16 education by fostering interactions among school and college faculty interested in outreach, teacher improvement, educational research, and curriculum development. The institute was a partnership between the College of Natural Sciences and Mathematics and the School of Education. In many ways, the Collaborative was a natural extension of efforts that had been underway as a result of a partnership between several science faculty at the University and the coordinator of the K-12 outreach program of the local higher education consortium. These individuals went on to become the PIs of the Collaborative. This group received its first NSF grant for teacher enhancement in 1989 for a program to improve in-service teachers' knowledge and expertise in space science and exploration and educational technology. They received another large NSF grant in 1992 to continue that work, adding to it the goal to encourage teachers to have their students engage in environmental research in their classrooms. As a result of these activities, a network of over 200 K-12 teachers was established in the region, with many of them taking on responsibility and leadership roles in the projects.

The institute's first order of business was to identify a funding possibility. Given the history of the previous efforts of the institute's leadership and NSF's description of the Collaborative project, a decision was made to pursue funding from that NSF program. Much of the early work consisted of meetings to develop a collaborative to go beyond the partnership of the previous projects to include the other colleges in the local consortium and the community colleges in the region. In addition, the school districts that had participated in the previous projects were invited to join the new collaborative.

It is important to note that, while on paper the Collaborative was a collaboration of institutions, from its inception it was operationalized as an organization of individuals. For example, when the proposal developers (the leadership from the previous projects) sought teachers, they invited teachers whom they had gotten to know from the previous projects to be participants, rather than contacting the school districts and having them do the recruiting. The same was true for the college and university participants. While a general call was made for participants, most of the faculty joined the project as a result of personal connections with the project leadership.

Over the course of 3 years, the Collaborative provided professional development workshops and funds for course revision to nearly 200 mathematics, science, technology, and engineering professors. These faculty revised many mainstream courses in science and mathematics to reflect the latest research in how students learn, incorporate modern educational technology, and model the kind of student-active learning that is called for in current reform efforts.

The Collaborative also initiated a program to attract and retain students in STEM disciplines and encourage them to become teachers. This was done in several ways. The Collaborative developed opportunities for undergraduate students to have teaching experiences, work as tutors or teaching assistants on their own campuses, or with precollege students in a variety of ways. These experiences were designed to encourage students to think about teaching careers early in their college experience. The Collaborative also identified promising students interested in teaching and awarded them scholarships. A Pre-Ed program, similar to a Pre-Med program, was established for students interested in the teaching of mathematics and science.

Findings

The findings of this study show that the Collaborative leadership and the K-12 teachers recruited as pedagogy experts espoused a set of beliefs about teaching and learning consistent with national science education reform efforts. However, K-12 teachers felt, at best, a dual level of Collaborative membership. Sometimes they felt like "kindred souls" as they interacted with university faculty. At other times, teachers felt quite distant, if connected at all. The data in this study indicated that a primary focus of the Collaborative on college science classrooms combined with the lack of development of previously planned K-12/college classroom linkages led to some of the misconnection or

disconnection. In addition, unaddressed institutional, social, and historical hierarchies led to interruptions in the development of community within the Collaborative.

Culture of the Collaborative

We began our study of the Collaborative using Schwartz's (1996) definition of culture as the beliefs, behaviors, and artifacts of a community. We found that we needed to distinguish between the enacted culture of the participants and what we call its *espoused* culture. This espoused culture is best described in the words of the former Collaborative project manager:

There will be a self-sustaining, local and statewide structure for improving the preparation of prospective teachers (elementary, middle and high school) and for increasing the scientific literacy and awareness of ALL undergraduates. There will be a sea change in the way college and K-12 science and math faculty...think about the purpose of education and the centrality of learning to classroom practice. The Collaborative will have produced real, tangible products, including new curricula, that college and K-12 faculty can turn to for improving their teaching. And, as a result of all of this, there will a larger, better-prepared, and more diverse pool of science and mathematics majors to become teachers at all levels, in the 21st century (Personal Communication, project manager, 1997).

As we read the statement of her vision, it became clear that what she saw was not just more math and science teachers and a more diverse teacher supply, but a cultural change in the way that teachers at all levels think about teaching and learning and the way they go about educating children, adolescents, and adults. That change is toward an educational philosophy recognizing that people construct their own understandings, promoting inquiry and student-centered instruction, and improving education for all people.

In a university press release in 1997, the lead PI of the Collaborative gave the following views about the type of education that the Collaborative promoted:

High on America's agenda is the need to improve the science and math education of its children. Science is in greater demand than ever in the workplace, and a host of careers, from biotechnology to computer engineering, are open to people who have a good grasp of science, math and technology. To meet society's needs, we need to change the way we teach science. The idea is to have students actively learning in the classroom, rather than just sitting there. Students work in small groups and try to think things through. It's not the

professor standing there lecturing, and then everybody goes home and does the homework.

The PI also said that the new and revised college courses would teach students to communicate well and to work effectively in groups and mirror the way business is done in the corporate and scientific communities. "Teachers will guide students in asking questions based on the students' own observations," he said. "Students will learn to design experiments, and collect and analyze data. Ultimately, we want students to understand that science is a process, a way to satisfy their curiosity about how the world works."

It should be clear that the Collaborative shared the educational philosophy of the current reform effort. Its documents spoke of promoting methods such as active-learning strategies: cooperative learning, investigation-based teaching, educational technology, new forms of assessment, and providing undergraduates with opportunities to teach. In its proposal to NSF, the Collaborative stated that the best way to understand the nature of science is actually to do real science, and therefore, it offered all undergraduates the opportunity to conduct original research.

Culture and Identity of the Participants

We found that K-12 Collaborative participants shared the culture that was espoused in Collaborative documents. This should not be surprising because most of the teachers had worked with the PI's in previous projects and had been selected by them to participate in the Collaborative (see appendix). Even so, it is informative to look at some of the comments that the teachers made in interviews and during classroom visits about their views of teaching, learning, and their identities as scientists.

Carl Ealing, a high school science teacher, made the following comments:

I respect my students very much...I feel that there's a need for teacher-centeredness but it should not take precedence over student ownership of their learning... I start off [class] by presenting either some materials or goals for the class period and then shift emphasis to the students...

Bob Fisher, another high school science teacher, told us, "Kids learn best by doing...a lot of hands-on activities...labs, modeling, manipulating objects." Doris Smith, a middle school science teacher, used an activity-based approach and was "a firm believer that kids need to work in small groups." Through group work, hands-on activities, and independent investigations, Lila Foster liked to give "kids a chance to learn as much as possible about issues that really affect their lives, and to help

them to look at their own choices, or at least their ability to make decisions.”

Gerard Boulanger, a student teacher in one Collaborative participant's middle school science classroom, found that the Collaborative's heavy emphasis on inquiry-based instruction dovetailed nicely with his natural learning style. "I've often found it hard to learn when teachers are just talking at me — I get distracted by trying to formulate a response to them, or simply watching them. Nothing goes in." Gerard believed that the Collaborative's hands-on science classes actually demanded far more of him than those he has taken in the past, because he had to do more than copy down notes and regurgitate them for the test.

Several of the teacher participants spoke about how they viewed themselves as scientists. In college, Barbara Klein "wanted to be a research scientist," but people told her, "Oh you would die in the lab. You'd be wearing this little white coat all day and be buried in a microscope, and you'd just hate it." She noted, "Obviously, [scientists] don't make discoveries every day, but I'm not sure they were right, and I was right in not pursuing it." As she described herself to us, it was clear that she considered herself a scientist. "I always tell my students that, and of course, they consider me a scientist from second and third grade. ... I have Dr. Klein on the door. ... I introduce myself as Dr. Klein, because I want them to know that blonde-haired women can be there." As a researcher with a doctorate in education and a teacher of 28 years, she enabled her students to engage in science as researchers. "A child has a wondering," she explained, "and they research it, and they research it [in] as much of a hands-on way as they can."

When asked to describe a scientist, Janice Marsten quickly fell into describing her daily scientific activity. I've been really digging into just having kids observe and then doing that myself. ... [L]ike you'll hear on the radio today the sun is setting due west. What's that mean? So I go outside my house, and I see where the sun is heading. How can I mark that? And what did ancient people do to mark that? ... If I'm wondering what is the best plant to grow in my garden, [then] I'm looking at the sun and the shade and taking all the different elements into consideration. Then [I'm] trying things, experimenting, setting up [an] experiment.

Janice worked with her students on a salmon restoration project and together they asked hard questions. "Why are we trying to bring the salmon back?" "Did they ever really come up here, anyway?" Janice viewed herself and her elementary school children as "citizen scientists" who attempted to "look at...the

deeper underlying questions," while they raised salmon to put them in the local stream.

"Kindred Souls"

In the benefits column, several teachers could see the positive impact that they had on the teaching of college faculty and college students' perspectives about children's learning. Barbara reported,

I do feel that I've had somewhat of an influence on these chemists that are hard nuts to crack in the Collaborative. [T]he chemists... were reluctant at first, and couldn't really see how they could change their courses and still teach what they needed to teach. And I think that they have come along... and I'd like to think that I had a little role in that.

Barbara noted that as college students visited her class she had them do an activity with her students. As a result, they "realized how excited kids can be about science."

Carl Ealing found that the "continued interactions with the physics curriculum... team did help to form more collegial, cooperative interactions between the university level and the high school. The curriculum team has helped me to feel free to talk about content issues."

Janice viewed her contribution as impacting education.

Older, grizzly, male college professors... really looked like they were breaking down some of the boundaries that they had put up for years. Hearing them talk [and] making me realize that a lot of their eyes were opened working with women... and realizing that they could learn something from an elementary teacher... I felt a great deal of respect towards me... I mean they would ask us questions and consider us part of that team... and they admitted that it was hard to let go of some of their preconceptions, and you could see them fall by the wayside, sort of. They would say, "Oh, I think that would work." And then you'd get together months later and they'd say, "I tried it and it worked" or "How do you do this?"

Janice described her experience as meeting with "kindred souls" in the geology group. She was intrigued that the geology professors from the area colleges did not usually talk much with each other—they did not get together and did not know what each other knew. So their sessions were the "meeting of the minds... the geology team work was much related to fieldtrips... we wanted to see what everybody else thought was so wonderful about this valley." The group sought to develop a computerized overview of local fieldtrips for

their students. "We met over pizza at a museum...and went on some wonderful fieldtrips. Up on the mountain, in this little observatory, we sat there in the wind and ate lunch one day, just talking about how the valley looks."

Distant Mis- or Disconnections

Though there were several such success stories, K-12 teacher participants felt sometimes as insiders and, at other times, as outsiders—not regular, full-time members of the team. They noted several obstacles to working with university participants, building their knowledge base, and further developing their teaching practices.

First of all, University participants making connections with K-12 classrooms, though part of the proposed plan, was not given enough attention and energy by the Collaborative. For example, following the field trip project, Janice did a "little bit of work" with one member of her group, the geology professor at the local community college, but "it was just so hard to get someone to come up here"—meaning her school district was so far away. It was located at the far northwest corner of the Collaborative boundaries. However, in reality, her school and students were only 30 minutes from the community college.

Janice also tried to link up with a professor in veterinary science from another community college.

I thought she was going to do something with my kids.... I could see these great things happening. But it was just too hard with community college students who were struggling with their lives to come up to my school district. It was disappointing, I guess, at one point I just finally realized that [it wasn't going to happen]...My expectation at the beginning [was] that I was going to work with some...[college] students. But I think that, more than anything, [it's] the remoteness of it.

Although Janice explained distance as the reason for the disconnection with college faculty, she *was* able to collaborate with another K-12 participant whose school was at least an hour distant. They set up an email/pen pal network for female students gifted in science.

Middle school teacher Robert Sajak provided another example of feeling "distant" and not part of the Collaborative. According to Robert, this was due to the Collaborative's early emphasis on college faculty development, while his was on K-12 teaching. In addition, he felt out of the loop as most of the Collaborative's communication was by email and he was not consistently online.

Teachers contrasted the feeling of distance and disconnection of the Collaborative with the

"camaraderie" and strong learning atmosphere of pre-Collaborative partnerships with college faculty. Barbara stated, "One of the things that motivated me [to join the Collaborative was] professional development." She had been part of the earlier partnerships described above. She stated,

I started off in something called PIES, *Partnership in Elementary Science*, which was, I believe, a NSF grant. [The partnership coordinator]—these were all her projects.... I was already doing those things when I went to PIES, [however] it was a reinforcement of most things. I got some great ideas, but the camaraderie, finding out that you're not the only one—literally I am the only person in [my] school system that does as much science as I do.... So I think that's it's been fun sharing some of the ideas with... people who teach more like you do.... Then I joined a group that [the coordinator] called *The Young Astronauts Leader Group* [that met] once a month just to share ideas.... [Then,] the teachers, many of us, became the staff of the [1989 NSF grant] for 5 years, and it was wonderful. The camaraderie... we were paired with professors. I had a geology, physics, and chemistry professor that I was paired with. I [would]... translate college knowledge into classroom practice, and I loved it, it was great.... Then from there I went to [the 1992 NSF grant] as a participant. It was interacting with people who were teaching science and loving it and knowing that you're very normal if you teach like this.

Janice noted, too, that it was the earlier partnerships—those geared toward elementary and middle school teachers that allowed teachers to build their knowledge base and comfort level with science and work side by side with college faculty—that spurred her to sign on with the Collaborative project. She said about earlier programs, "They were so intense. You really got into it." Elementary teachers noted how they had made some lasting friendships through these programs. Janice remarked,

I meet them in the store; we're usually there for a few minutes to an hour just gabbing about what's happening. Great ideas, great ideas from them, and I hope I've influenced them, too. It really impacted on your year. [The Collaborative] isn't something that would impact a current elementary teacher's work, as much.

Thus, the earlier relationships were rewarding in many ways. They brought teachers out of the isolation they experienced in their school settings due to their nontraditional teaching approaches and confirmed for them the sense that their pedagogy was grounded in

research and supported by other professionals. Workshops were spent sharing ideas and growing as educators. Professional friendships were well established. Thus, their personal science activity, science teaching, and acknowledgement from peers and college faculty enabled them to develop a strong sense of social and self-identity as scientists.

In the Collaborative, the less-than-hoped-for connections between university faculty and K-12 teachers can be accounted for by examining institutional and historical structures. First of all, there was a major change in the Collaborative leadership early in the project. The initial partnership coordinator brought extensive experience with local teachers and K-12 settings through her work with teachers during previous university projects. This individual left the Collaborative, and the person who replaced her came with fewer connections and less experience with local teachers and schools. Thus the teachers' role in the student program was not developed. Most of the teachers were going to be mentors of undergraduate teaching experiences but little energy was placed in that direction. The initial 2 years of the project were devoted to the professional development of faculty and their courses. The focus on undergraduate teaching and their work in K-12 classrooms was put off until to the 3rd year.

In addition, the social structures developed under early projects provided K-12 participants with insider status. Many were staff members in these earlier efforts and had an active role in the development of both the partnerships and the co-construction of new pedagogical and content knowledge. Teachers' roles as pedagogy experts in the Collaborative, though highlighted, were, in actuality, not as active and underutilized.

Last, in order to make a "sea change in undergraduate education," NSF implied that the proposal needed to be couched in teacher education in order to attract undergraduate faculty to change their practice. The strategy was to convince undergraduate faculty that through their changing practice they were "going to help us educate teachers better" (Personal communication, PI, 2002). NSF required that the PI for the project be based not in education, but one of the STEM disciplines, which resulted in some limitations on the understanding of and focus on public school teachers and schools in the project.

In addition to less-than-hoped-for collaborations, some K-12 teachers felt discomfort with the presence of an implicit hierarchy. Barbara shared her experience of residing at the bottom:

I'm a lowly elementary school teacher, and I do feel that I spend a lot of time justifying my role in the

discussion groups. I just feel that I was constantly proving myself, and felt this incredible pecking order... you know, the elementary school teachers were the low man. The middle school teachers, we give them a lot more respect, high school teachers. Part of it was not even...snobbery, but a college professor could not think of his chemistry [students] teaching in elementary school, and could hardly think of them in middle school, could maybe think of them teaching high school. It was that kind of thing.

Secondary teachers also felt the varying levels of status. One described how he was rebuffed when he sought out collaborations with college faculty. "I had college faculty saying they were really busy, and there was no way my students could visit their lab, because they had a lot to do. There was more than a strong implication that secondary education's kind of a joke, and you're not busy."

Barbara made this hierarchy explicit at a summer Collaborative workshop when participants were invited to introduce themselves. Participants (university, college, K-12) proceeded to provide their names, schools/institutions, and the courses and the level of students they taught. One after another, university and college faculty increasingly added to their professional profiles by describing their graduate courses and their research interests. Toward the end of the introductions, Barbara exposed the layers of status when she introduced herself as a "faculty member at Harvard teaching only graduate students."

Joyce described how status emerged in the discourse of whole group sessions during Collaborative workshops.

The skepticism really kind of got me down... People kind of try to outdo each other in finding fault with the presenter, or with a certain notion... People were not disagreeing in a polite way, and it almost became this one-upmanship... It seemed like some people were in it to prove the goals wrong... It's okay if your skepticism grows out of trying something, really trying something. Not like, "Oh I tried it one semester," or "I tried it this week," but really with a desire to make changes and to look at yourself as maybe needing to make changes. I mean, I think a lot of the skepticism was really kind of on the surface without people even trying things... I was turned off by some of the eye rolling and attitudes when people were disagreeing.

Frank Reilly's participation as a pedagogy expert in the Collaborative ended after the first summer of the

project. When interviewed, he told us that he saw a clear hierarchical difference between college faculty and K-12 teachers and that decision-making power, financial incentives, program planning, and degree granting power all were at the top of the hierarchy.

For example, Joyce Davidson shared that she collaborated with a math faculty member over the course of three semesters. Joyce wished that her collaboration with the professor had been “stronger.” Even though she participated in the Collaborative math groups, most of the talk was around content knowledge—“what can we do to make the math program stronger for people going into elementary teaching.” Joyce viewed course improvement from another perspective. She had taken the same math course as a graduate student, taught with a different approach, and enjoyed it. Two former teachers taught the course. “One of them did all the math, and one [focused on] ‘What does this look like in a hands-on kind of way?’” However,

there was some issue with the math department, that it was too much of a methods course versus math content....The [focus of the present] class typically is just really on math and there’s not the “every class” kind of attempt to connect that into real schools, real classrooms, real teaching.

She said she thought, “The whole course could have been taught... so every week they got the content, but then the process.” Yet, the math department and the college faculty member determined the course design. Joyce had little say about that. She described her role as, “I went to the class; I visited; I talked about the number system and first graders; I brought the kids there; [the students] did some number assessment with them.”

Discussion

Culture and Identity Within the Collaborative

Because teachers and college faculty members shared the same culture, it seemed reasonable to expect them to see themselves as part of the same community. However, in this case, many K-12 teachers did not. Although the K-12 teachers were “on the team,” received the “letter jacket” in the form of the title “pedagogy expert,” some felt “benched,” so to speak; they did not feel like they “got to play” regularly and fully with the team.

This is contrary to our earlier definitions of culture and community. Culture and community appear tightly linked. It seems as if culture is defined by a community, and what constitutes a community is in part the “beliefs, behaviors and artifacts that make up its culture”

(Schwartz, 1996). So how do we explain what we found in our study of the Collaborative?

According to Blum (1999), people’s ethnic identity, which could be thought of as their culture, can exist separately from their participation in the community that has created or lives that culture. When people’s ethnic identity coincides with their community, it is what Blum has referred to as thick ethnicity. In the case of the Collaborative, this label would apply to people who share cultural beliefs about teaching and learning and are legitimate participants in the Collaborative community. The prime examples of thick ethnicity are the project PIs. They proudly wear the “letter jacket,” emblazoned with the “varsity letters” that signify their legitimacy in the community.

Although we do not represent them here in this article, there are also examples of Collaborative participants who exhibited identity ethnicity. Some college and university faculty participated in the workshops and accepted funds to help change their courses but did not share the Collaborative’s espoused culture. Because they partook in Collaborative activities, they had access to the letter jacket. Although few of them were awarded the “varsity letters” signifying that they both “talked the talk” and “walked the walk,” outsiders to the community still identified them as being part of the Collaborative community.

Thinly ethnic people share some aspects of the culture but are not part of the group’s community. This describes the relationship that we saw for most of the K-12 teachers whose participation in the Collaborative we studied. What this means is that they shared the beliefs about teaching and learning science that have been at the center of this 20-year-old reform effort but did not see themselves as legitimate participants in the Collaborative. Although they were entitled to wear the “school colors” they could not or chose not to, because they lacked full legitimacy within the Collaborative community.

Of what importance was this community structure to the Collaborative and its participants? How did it facilitate the Collaborative or impede it from reaching its goals? What effect did it have on the K-12 participants’ development?

Kinship and Learning Communities

K-12 participants reported that they gleaned little new knowledge, established few new networks, and had little place within the Collaborative community. However, as K-12 teachers described their personal scientific activity, their science activity with their students, and their work in pre-Collaborative projects with

colleagues and college faculty, they described these contexts as places where individuals worked together to produce new knowledge about both the world around them and their teaching practice. Palmer (1998) called these kinds of learning settings “communities of truth.” In such communities, the focus of group members’ attention is what they hope to learn, change, and/or achieve; this subject receives the respect and authority often given individuals and institutions. Palmer stated,

The connective core of all our relationships is the significant subject. . . . As we try to understand the subject. . . we enter into complex patterns of communication-sharing observations and interpretations, correcting and complementing each other, torn by conflict at this moment and joined by consensus in the next. . . . Conflict is the dynamic by which we test ideas in the open, in a communal effort to stretch each other and make better sense of the world. (p. 103)

As K-12 teachers were considered “experts” in the Collaborative, they were not viewed as learners and so were often on the margins of the “communal effort” that Palmer wrote about, especially when the project moved outside of the formal workshop settings.

In addition, K-12 informants noted implicit historical and institutional hierarchies and perceptions of status within the Collaborative that diminished the legitimacy that came with their given role as experts. Such dynamics interrupted and limited the Collaborative’s efforts to learn, change, or achieve—to focus on the “significant subject” that Palmer argued as holding the key position as the “connective core” of a community (p. 103).

In a community of truth, each participant is a vital part of the social context. Cohen (1990) argued that “intelligence is multidimensional”; each participant brings multiple abilities, talents and expertise needed to construct new knowledge. As a result, each member’s contributions and efforts must be valued in order for the community to be successful. Thus, addressing relations of power in educational settings and reflecting upon the traditional roles and status levels in STEM settings can enable individuals to better foster effective teamwork in not only Collaboratives such as this one, but also in their professional environments and classrooms.

In addition, new communication opportunities and decision-making structures need to be created, encouraged, and supported for reform-based educational communities such as the Collaborative (Davis, 2003). As it was, institutional structures, such as university departments with their concomitant policies and perspectives,

were impediments that appeared insurmountable to Collaborative members.

Conclusion

A collaborative like the one that we studied is a newly created institution that is connected to other, previously existing institutions. This Collaborative attempted to make itself into a collaboration of constituents from all institutional partners (the participating colleges, the university, and the surrounding school districts) and all levels of instruction. What we found was that the Collaborative’s community was constrained and narrowly focused as a result of long established institutional, social, and political structures which marginalized, delegitimized, and excluded some people, and/or was unattractive to others. The development of new understandings about teaching and learning and the formation of new learning networks were compromised as a result.

Our model of educational reform suggests that for a collaborative to evoke change it must not only be an institution, but also a community with its own culture. Thus, when a collaborative is conceived, a new institution is being constructed, and reformers must look inside and outside of the new construct at the forces that shape it: issues of status (e.g., instructional level, differing expertise) and the political context (K-12 schools, the university, NSF). As collaboratives seek to change the status quo, their role as change agents in the political arena must be acknowledged. Hierarchies must be examined, and the legitimacy of all within the community made explicit. New decision-making structures and methods and contexts for communication need to be created, acknowledged, and supported. These actions are critical if such reforms are to be successful and all participants are to proudly wear the “letter jacket.”

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Appendix Participants

Name/ Grade Level	Science Back- ground (Family/ College)	School district support (e.g., profes- sional develop- ment in science)	School of Education Graduate degree	SSI Parti- cipant (State- wide Systemic Initiative)	PIES Parti- cipant (Part- nership in Elem. Sci.)	Young Astronauts Leadership Group Member	1989 NSF Grant Parti- cipant	1992 NSF Grant Parti- cipant	Collabora- tive Course Participant	Developed a Classroom Project w/a Collaborative Faculty Member	Developed a Classroom Project w/a Collaborative Faculty Member	Taught/ Co- taught Collabo- rative Course
Joyce Davidson/ES		X	X (M.Ed.) X (Ed.D.)	X	X	X			X	X	X	X
Barbara Klein/ES	X		X (Ed.D.)	X	X	X	X					X
Janice Marsten/ES	X	X					X		X	X		
Theresa Wolford/ES	X	X	X (Ed.D.)									
Maria Sanchez/ES		X		X								
Shawn McAlister/ES	X	X		X								X
Donna Allen/ES		X										
Anna Weisman/ES		X	X (M.Ed.)	X	X	X	X	X	X	X		X
Carl Ealing/HS	X	X	X (CAGS)	X			X	X		X		X
Bob Fisher/HS	X						X	X		X		
Doris Smith/MS	X	X	X (M.Ed.)				X	X	X	X		
Lila Foster/ MS	X						X	X		X		
Frank Reilly/MS	X		X (M.Ed.)				X	X	X	X		
Gerard Boulangier/MS	X		X (M.Ed.)						X	X		
Robert Sajak/MS	X		X (CAGS)	X			X	X	X	X		X
Mark Kellogg/HS	X			X			X	X		X		
Deborah Cooke/MS	X						X	X		X		

Note: X indicates that the participant has the characteristic noted and/or participated in the activity listed. ES = Elementary Level, MS = Middle School Level, HS = High School Level. M. Ed. = Masters in Education, CAGS = Certificate of Advanced Graduate Study, Ed.D. = Doctorate in Education.