Chapter 19
Supporting New Members as They Transition into Our Science Education Community of Practice

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Introduction

In the science education research community, the doctoral program is the traditional pathway into the profession. Students are expected to take rigorous classes, become actively involved in research projects, contribute to knowledge generation and work toward establishing themselves as experts in an area. Like the wearing of the robes and doctoral hoods at graduation ceremonies, there are many aspects of the doctoral program that predate the existence of the various doctoral programs or their faculty members. Some of these aspects are maintained because they serve the program well, some because of tradition, and others simply because we have not stepped back and reflected on the purpose or effect of our procedures. In part, this can be attributed to the fact that doing so involves time and effort for something that was not valued at most academies in terms of merit review, tenure and promotion. This is changing, however, due to the increasing understanding, acceptance and value for self-study research at many institutions of higher education.

Our doctoral program, part of the Department of Curriculum and Instruction in the School of Education, prepares future science educators with a primary focus on their efforts in science teacher education at all levels/venues of science education. We bring in new members with the promise that, while here, they will "build upon [their] own passion for science with the knowledge and skills to teach this material effectively to a diverse, multicultural student body. [They]'ll also hone [their] data interpretation skills and participate in diverse research projects aimed at improving young learners' understanding of scientific concepts and best practices for educating the next generation of science teachers" ("Degrees & Programs: Science Education", 2015 http://education.indiana.edu/graduate/programs/science-ed/index.html).

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We bring in two to six new members every year, most of them supported by assistantships involving teaching future formal K-12 science teachers in our undergraduate program. Many of the past graduates of this program are now science educators at institutions of higher education around the world; conducting research, teaching and service that involves science teacher education. Ours, like most doctoral programs throughout the world, is steeped in history and tradition.

Over the course of the next 5 years, we will systematically explore the curriculum of our graduate program. Curriculum is being defined as students' actual opportunities, experiences and learning (Posner, 1995). The purpose of this self-study, the first in a series of studies, is to explore how well the traditional interdependent processes inherent in the curriculum of our science education doctoral program is functioning in terms of bringing newcomers, first-year doctoral students, into the contemporary field of science education. Specifically, we looked across the components of our doctoral program curriculum by focusing on how well it influences identity formation and legitimate participation in the science teacher education community of practice.

Initial Theoretical and Practical Understandings

Social constructivist theory explains how social and cultural interactions influence an individual's creation of understanding (Vygotsky, 1978; Wertsch, 1991). The explanation is grounded in the notion that understandings are mediated within the milieu in which they are carried out (Wertsch, 1991). Thus, the focus of this orientation is not solely on the individual learner; but rather on the learner and learning process as participation in experiences in a socially constructed world. Sociocultural theory of practice (Lave & Wenger, 1991) explains both a socioculturally structured world and the persons who function within that world. Sociocultural structure refers to the institutional, historical, and social activities in which humans engage as a matter of survival and comfort (Giddens, 1979). When humans share a commitment to a shared domain of interest and build relationships that enable them to learn about and within that practice, they form a Community of Practice (CoP) (Wenger, 1998). These communities often have core and peripheral members. We all belong to many communities of practice, serve in a peripheral capacity to many others, and travel through numerous communities in the course of our lives.

The members of a CoP engage with one another and thus identify themselves and others as members of that community. In light of this, there is a connection between identity and practice as the formation of a CoP involves the negotiation of identities (Wenger, 1998). We view identity as developing through individual and collective processes that occur in social institutions such as K-12 schools, or in our case, universities (Gee, 2005; Packer & Goicoechea, 2000). Through participation in social activities and discourses within institutions, individuals form values and ways of being, which enable them to develop identity (LeCourt, 2004). Identity formation is a process through which individuals come to "know and name themselves"

(Danielewicz, 2001, p. 3). Membership in a CoP translates into a sense of familiar, understandable, and judging oneself and others to be competent in that community (Wenger, 1998). In order to make a successful transition into the CoP, new members need to take on an identity of a member of that community. Gee (2001) describes four perspectives for understanding identity development. He labels the four perspectives as follows: the nature perspective, the institutional perspective, the discourse perspective, and the affinity perspective. These perspectives are not separate from one another, and act in concert with one another. The nature perspective includes aspects of identity which are recognizable and with which we are born, such as gender, race, personality, and physical characteristics. Sources of identity for the institutional perspective are the institutions and those in power in the institution. Those in authority can grant or impose roles on individuals—e.g. as advisors we can impose roles on individuals to help them become part of the institution so they can take on the identity of a science educator. The discourse identity indicates that individual identities are created, recognized, sustained in and through the dialogue with others. It is through this process that identity is claimed for oneself and named by others (Danielewicz, 2001; Gee, 2001, 2005). An identity is claimed by how we define ourselves and to others. Affinity is the fourth perspective, which is comprised of individuals who are available to one another in terms of access and participation in certain practices. Affinity groups work in the sense that its members all accept, believe in, value and abide by a set of practices.

Lave and Wenger first coined the term 'community of practice' while studying apprenticeships. This theory allowed for a more comprehensive understanding of an apprenticeship experience that involves a complex set of relationships that serve as a living curriculum for the apprentice. Wenger noted that learning in practice, as is done in an apprenticeship, is negotiating an identity. Depending on how a community of practice negotiates individuality, different degrees of continuity and discontinuity fashion the members' identities. The encounter is a complex meeting of the past and the future of a community (Wenger, 1998). This process by which new members become part of the community of practice is termed 'legitimate peripheral participation' (Lave & Wenger, 1991). Members of a community make decisions about their participation and act on those decisions (Giddens, 1979). Although these members are guided by historical precedence (continuity), they have the ability to introduce new practices (discontinuity), which may change the visions of other community members. The change a member attempts to make to a CoP creates tensions; as such transformations are resisted by a tradition of social reproduction (continuity-displacement contradiction). This is referred to as the 'dialectic of practice' (Giddens, 1979; Lave & Wenger, 1991). The newcomers, however, do not necessarily provide the displacement. Wenger noted that often the new members do not necessarily want to emphasize discontinuity as they seek to gain access to a community and sometimes old-timers may welcome the new potentials afforded by incoming members.

Many of our current practices and understandings in carrying out our work in higher education are based on the theoretical notions of CoP and identity (as explored above). Higher education communities, however, involve unique

characteristics that must be taken into account when applying these understandings. The members of the university are providing students with the knowledge and experiences to be applied outside the learning system. Specifically, in doctoral programs in science education the students are expected to leave our university and become part of a broader learning system. That larger learning system, however, is our science education CoP. We are not only the old-timers referred to in the CoP literature, but also the teachers. In light of these unique aspects of our community, we and the initial theoretical and practical understandings that we are bringing into our study must themselves be the primary participants.

Self-Study Approach

Self-study in science teacher education is being defined as rigorous, critical inquiry in which science teacher educators research themselves and their practices. Russell (1998) describes self-study as learning from experience embedded within the teachers' process of creating new experiences for themselves and those whom they teach (p. 6). Loughran and Northfield (1998) define self-study as recognizing that the dissonance between beliefs and practice is fundamental to action. One common thread throughout all of these definitions is studying or voicing one's own experience, expressing oneself or knowing oneself and one's practice better. It is within the self-study tradition that we put our selves and our practices within the academy in the forefront. In terms of the methodological approach, "we," the authors of this study, and our theoretical and practical understandings are the primary focus of the data collection and analysis process.

The self-study approach utilizes a wide variety of methodologies. These include case study (e.g. Kroll, 2005), narrative (e.g., Kitchen, 2005) and heuristics (e.g., Oda, 1998). The methodology used for this self-study was heuristic. Heuristic methodology (Moustakas, 1990) seeks to uncover the nature of phenomenon that is being studied through the use of internal pathways of self through utilizing the processes of self-reflection, exploration, and elucidation (Douglass & Moustakas, 1985). This methodological approach is "…concerned with meanings, not measurements; with essence, not appearance; with quality, not quantity; with experience, not behavior" (Douglas & Moustakas, 1985, p. 42). This approach is different from other methodologies in that the researcher is a participant. It is that person that identifies the meaning and essence of the experience. If other participants are involved, they are viewed as important co-researchers who are an integral part of the heuristic process (Moustakas, 1990).

We, more specifically our theoretical and practical understandings of doctoral education, were the primary participants. Our self-study group included two professors whose main responsibilities were to a science education program at a major research-intensive university. Each of the authors has a story to tell about this process and personal understandings and practices, yet we worked through the process presented in this chapter together. This process included much collaboration,

consensus and social construction of understanding. Thus, the first-person "we" is used in reference to this experience. Although the specific data (e.g., quotes) may have been from one of the two authors, they were selected to represent "our" experience and not that of the individual. Thus, they are credited to authors.

The focus of this 1-year exploration was on our understandings and practices in regards to supporting new doctoral students as they transition into our science education CoP. The first-year students were more than subjects in our journey. They were considered co-researchers in our meaning-making journey. Three of these students were from science education areas outside of formal K-12 education. One is an environmental educator working to enhance her understandings of that field and the preparation of future environmental educators. Another is working to enhance her understanding of informal science education and informal science educator preparation. The third student of this group wants to continue to make an impact in regards to equity and social justice issues in science education. She is seeking to enhance her understanding and opportunities to make such impacts, including preparing science teachers who teach in equitable ways. Two of the students are both former high school science teachers seeking to enhance their knowledge and practice in regards to preparing teachers for the formal K-12 classrooms. Each student, of course, has a unique story throughout her or his first-year in a doctoral program, yet the professors' theoretical and practical understandings of mentoring first-year doctoral students were the major focus on this chapter. Thus, only the specific aspects of the students' stories that impacted our own understandings are shared.

The main data sources were audio-recordings from our meetings and written reflections by the students and by the faculty members. To better connect these understandings and practices to the lived experiences of the students they affect, we analyzed the program data of the entering doctoral students. The qualitative data tools used to collect this data included: (1) audiotapes from seven collaborative researcher reflective meetings, (2) researchers' individual written reflections following reflective meetings, (3) field notes of individual and seminar meetings, (4) audiotapes of six doctoral student focus-group meetings, and (5) written documents, including forum responses, from seminars and program activities.

The heuristic analysis process sought to capture the experience and our understandings within. This process included engagement, immersion, incubation, illumination, explication, and critical synthesis (Moustakas, 1990). The initial engagement was a time for self-dialogue and inner search to discover the topics and questions that need to be addressed. This was a personal process that involved much contemplation on the nature and focus of the program and the reasons for doing this study. During the immersion stage, we became totally immersed in the experience, questioning, dialoging, indwelling, feeling, etc. Once the questions were decided upon, the data collected from the first year of these doctoral students' experiences, noted above, were reviewed with those questions in mind; however, 'the' answers were not sought. This was a time for us to reflect and contemplate on the questions and possible answers. This was followed by the incubation stage: a time to step back and allow tacit understandings and new understandings to take place. We took several weeks off from meeting or discussing the project to allow for personal

illuminations. After this is the period focused on illumination. We came back together to share and discuss the illuminations and seek a consensus of understanding. This is the point where the researchers allowed themes and patterns to emerge. This was refined during the explication stage when the patterns and understandings were refined and relationships were sought. Finally, we put it all together through the creative synthesis stage; focusing on fleshing out the new perspectives and meanings. This is a personal way of communicating our self-study process and the understandings that resulted from this process. We chose to communicate through a narrative of the areas in which we believe our understandings and practices have grown. We locate the following discussion in a theoretical framework that draws on sociocultural understandings of learning, community of practice, and identity development. Throughout, this narrative is supported with the findings of our own understandings and experiences, as well the student voices that shaped those understandings.

Context

The doctoral program requires a minimum of 90 semester credit hours, the successful completion and defense of a professional portfolio and a science educational research dissertation. The required coursework for our program involves three main areas: (1) the field of science education (major), (2) the discipline of science (minor); and (3) research methodology, The coursework for the field of science education has a common core of courses that includes professional seminars and topical seminars. The seminars represent a broad overview of the science education CoP. The assignments in these seminars are, in part, structured in a manner that allow the students to focus on an area of specialization from multiple perspectives. The minors are developed with a faculty member from one of the science departments. In addition to the courses in these areas, students are required to select elective/support courses in their own areas of study. Following the completion of the courses, students present a professional portfolio that is assessed for its written components and the student's oral defense of such. This portfolio includes aspects of the doctoral program experience that are not achieved through traditional coursework. These aspects include research experiences, publications, presentations, grant-writing experience, evidence of the scholarship of teaching in higher education, and evidence of skills in research design. Following a successful written and oral defense of the professional portfolio, students complete the dissertation. On average, the students complete the program in 4-to-5 years. Throughout the program, students take part in focus-group sessions designed to further foster a sense of community, reflection and allow the faculty to remain informed about the graduates students' lived experiences within the program.

During the first year in the program, the focus of this chapter, the doctoral students take the first two professional seminars, design and implement a self-study or action research project on their teaching, select an advisor, develop a program

of study, take part in professional seminars and focus–group sessions, and begin to take part in current research programs in the department. They also take several elective/minor courses depending on their area of interest.

Findings

In this section we describe our results. We organized our findings in subsections that relate to the exploration of our CoP and our insights into confronting our own understandings of how we are supporting the development of our students' identities as science educators.

Our Understandings of the Boundaries and Peripheries of Our CoP

We acknowledge science education as a multifaceted CoP focused on enhancing scientific literacy of all learners. There are various sub-communities within the CoP that differentiate themselves and also interlock with each other. We recognize that science education goes beyond formal K-12 science teacher education. Each of the faculty members within our program, however, held formal K-12 teaching positions prior to entering higher education and strongly values our state certification program for science teachers. So much so, that despite the fact that we acknowledge other aspects of science education (e.g. higher education, informal science education, etc.), our data suggests our actual shared practices were confined within an unintentional boundary around formal K-12 science teacher preparation. Although the connections and overlaps with other communities in science education were theoretically acknowledged, they were not evident in our practices. As a result, we were leaving some of our new students feeling like they were entering the wrong CoP.

For example, the three incoming students who were not public school teachers, and who did not intend to work in formal K-12 science teacher preparation, reported feeling disconnected from our science education program. These reports came early in their transition into our program. In a forum discussion in September, one of these students reported that she felt disconnected because her interest was in higher education, working in chemistry education to encourage and open doors for underrepresented science students. A second felt disconnected because her emphasis was on environmental education and was not seeing that as part of science teacher education. Similarly, the third student felt disconnected due to being interested in informal science education. Early in the program, these students started questioning whether they had entered into the wrong CoP. At one point, all three told us that they seriously considered leaving the program due to this perceived disconnection. In contrast, the two incoming doctoral students who were former classroom science

teachers and who intended to become formal K-12 science teacher educators felt no disconnect from the science education program. They also began to question the fit for the their fellow students pursuing different pathways. For example, one of them asked, "What do those of you who do not intend to be university professors [in K-12 teacher preparation] hope to gain from the program?" (Forum, December). Such statements indicated that something about our program made it appear to be a mismatch for anyone outside of formal science teacher education.

As we reviewed our curriculum for insight into how such feelings of disconnect could occur, we realized that many of our practices were developed based on our narrow definition of our CoP. One example is our science education pro-seminar that occurs once every month. We added it to our program as a way to connect all our students—incoming and experienced—as well as all faculty, and to build our CoP. However, our self-study made us realize that it did not seem to be serving that function. Indeed, something about it seemed to foster a sense of disconnect for some of our new members. Several of the students expressed feelings of discomfort and expressed that it had nothing to do with areas of science teacher education that exist outside of K-12 formal teacher preparation. Another example is our required readings list. When we came across one student's comment that nothing connects to environmental education—we took a critical look at our list and realized that none of the readings that we required, and therefore deemed important for all to know, connected to environmental education, informal education, or higher education. We realized that the major projects in our doctoral qualifying portfolio could be adapted to a broader view of science education beyond formal K-12 science teacher education. However, nearly all of our required course readings and assignments, as well as our field-reading list, were focused on formal K-12 science education. This can cause a problem as it establishes boundaries we do not wish to have, nor did we realize that we had them. When we reflected on this narrow understanding and the accidental boundaries, we questioned whether we were poised to address other areas outside of formal K-12 teacher preparation. After analyzing the data from the first semester, we noted:

> The second thing that surprised me the most was the degree to which we may not be meeting everyone's needs. They seem unfulfilled by what we're offering in our classes/program and are looking outside of our program…I question whether we are a science education program or a science teacher education program. We don't seem to be meeting the needs of those that don't see themselves preparing future [K-12 classroom] science teachers. (Researcher Reflection, 1)
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> We wondered, "Can we even really support people with different career goals than our own? How can we help mentor someone for a career that we don't know?" (Researcher Reflection, 1).

As we continued data analysis with these questions in mind, we noticed that the sense of being in the wrong CoP seemed to disappear. We realized that the students had made connections with others in the peripheral of our CoP over the course of their first year that ultimately helped them realize their place in our community. The student that focused on equity issues in higher education found connections through a second major in educational research methodology, the student that focused on

environmental education found a connection with a professor in environmental and public affairs who is now serving as her minor advisor, and the student emphasizing informal education found connections through the Informal Science Education Strand at NARST. They came to believe that they had a place within the larger CoP. The students themselves worked through their own thinking and were able to articulate how their ideas of science teacher education were different from the working definition of such in our CoP. The environmental educator noted that her definition of 'teacher' included future environmental educators in the field or at a particular outdoor center. With the doctoral degree, she wanted to be prepared to educate those that she may supervise. The informal science educator noted that the doctoral degree would allow her to prepare/work with people in informal science education environments such as museums. The student emphasizing equity issues noted that she is preparing to educate instructors at all levels, pre-K-university, to teach science in an equitable manner. These students indicated that they were glad that the curriculum of our doctoral program enabled those connections to be part of their program, and they affirmed that they enjoyed the program. We noted, "ironically, this reveals that because of the connections outside of the program they felt more at home within the program" (Reflection Meeting, 5). These connections were allowed, in part, due to the electives/support areas of our program, required minor outside of our program, and opportunities to build collaborations within course projects.

Another aspect of our program that was revealed to be instrumental in fostering a sense of belonging in our CoP was the responsive curriculum. This was fostered by the: (1) faculty's willingness the discuss areas of expertise differently from their own; (2) series of semi-structured focus group sessions that took part throughout the year; and, (3) annual review of the doctoral students. These aspects of the program allowed us to hear the first-year doctoral students' explicit and implicit concerns about the CoP, and we were able to respond both verbally and in practice. This helped us to provide a responsive curriculum that ultimately allowed them to find a place in the CoP. A student, reflecting on finding a place in the program in the first year, noted: "The faculty is open to new thoughts, other ideas…it would have alienated me if I felt like I was being put into a box." Another student agreed, "Yes, that's something I appreciated…I feel like we have a lot of agency … to do what we're really interested in and not forced to do something just for the sake of doing it…" They continued and ultimately noted that this was realized through the components of the program that allowed them to voice their needs and concerns. They seemed to enjoy the focus-group sessions and found the informal conversations to be a time and place for them to explore and challenge their ideas about the science education CoP. They requested that these continue in the coming years in the program and increase in frequency. For example, one student noted, "I feel like these conversations are really helpful…sometimes I have things figured out in my head, but it sounds differently when I'm actually saying it out loud." Another student strongly agreed, "Oh, it helps." And a third student followed up, "I think it helps! I don't know what I don't know… these conversations bring things up that I just wouldn't have figured out on my own" (Focus Group, May).

Overall, our findings challenged our narrow definition of our CoP. This was a definition we did not realize we held. Fortunately, the unintended boundaries of the CoP that resulted did not result in the loss of new potential members. This was, in part, due to the aspects of our curriculum that allowed the students to extend those boundaries on their own and our discussion of our theoretical understandings of the CoP. To address the gap between our understanding and practice, we need to revise those aspects of the curriculum that were too restrictive.

Our Understandings and Practices Associated with Students' Identity Development

In our program, we seek to use the components of identity formation (noted earlier) to help our doctoral students develop identities as science educators and join our CoP. With this self-study, we sought to decipher at what point they took on the discourse identity of a science teacher educator, as well as a science education researcher. At several points throughout their first year, we asked them to consider these identities and whether they believed they were a science teacher educator and/or researcher. They seemed to struggle with determining exactly what that meant for them. Early in the school year they were concerned about teaching science to undergraduates. For example, one student stated, "I am concerned with my lack of being a "science teacher" because I am an environmental educator. Science can be construed as boring and negative (Forum, September)."

What we were surprised about is that they did not see themselves as science educators very early—they seemed to struggle with developing that identity. Some of this, of course, lines up with what was later discovered to be our narrowly focused practical definition of our CoP. Our own identities as science teacher educators influenced how we approached our mentoring of new doctoral students—intending to support them as they identified as formal K-12 science teacher educators. The struggle, however, was not reserved for those students. The students that were former K-12 classroom teachers also struggled with defining and taking on these identities.

As the semester went on, the students reflected on themselves as teachers in higher education, and seemed to focus mostly on teaching their students. They were first seeking to develop a conception of an effective teacher educator. For example, a student noted, "I am busy reflecting on myself as a teacher, wondering how teaching at the college level is different from what I did before" (Forum, October). Another student followed this statement with, "My ideas about teaching have shifted, and I am transforming to one view about effective teaching" (Forum, October). Regarding their views of being science education researchers, they seemed very jumbled and confused. In fact, one student stated, "I have no conception of myself as a researcher—I am a jumbled hot mess, and I am working on a focus" (Forum, October). This statement clearly indicates that he had not begun to

develop an identity as a science education researcher. Another in the group was a bit more positive, stating, "Others may see us as researchers when we ourselves don't yet—we are transitioning" (Forum, October). This statement indicates that though she has not taken on an identity as a science education researcher, she recognizes that those outside may see her as a science education researcher (Discourse Identity), and recognizes the transition toward that identity.

At the end of the first semester, there were still questions among the students as to whether they actually were science education researchers. Most had not taken on that identity. For example, one student said, "A science education researcher is someone who contributes to the field of science education research through their work. I am not one because I have not contributed" (Forum, December). Similarly, another disagreed that he was a science education researcher because he had not published. A third student provided a definition, but did not claim to be a science education researcher. A fourth student, on the other hand, had developed an identity as a science education researcher. This was evident in quotes such as, "A science ed researcher is someone committed to understanding and improving science education through research. And yes, I am one—because I am committed to understanding and improving science education" (Forum, December).

This slow development of an identity as a science education researcher carried through to the end of the school year for most students. It seems that the one student that did identify as a science education researcher maintained her identity by her own realization that it did not need to be part of a university setting. She stated: "It is not limited to the academy—it is anyone who wants to improve science education. And yes, I am one because I am doing research and producing knowledge" (Focus Group, May). We found it surprising that the three students who did not initially see themselves as part of our CoP identified as science education researchers before the two students that never questioned the fit. The two that immediately identified with the CoP did not show indication that they had developed an identity as a science education researcher. One stated, "I am on a continual path toward being a science ed researcher. I still need to find myself as a researcher." The second stated, "I am not a science education researcher. It needs to be someone who has published. I have not published research in science education" (Focus Group, May).

In the institution of the science education program, the science education faculty members are the authorities, and therefore, the source of power (Gee, 2001). How we approach mentoring students into the CoP is therefore very important. The discourse we have with our students, as well as the discourse they have among themselves, and with more senior students, will influence their identity development (Danielewicz, 2001). They may develop an affinity group that consists of students, and therefore their identities may be more aligned with those students rather than aligned with a conception of a science educator, unless those students also have a well-developed identity as a science educator. For us to better foster their development of an identity as a science educator we realized that we needed to better understand their current identities, and the identities that they intended to take on within the science education community of practice. However, it is not clear to us that they actually know this information themselves. We noted, "…the students don't seem to

know what they are pursuing. How do they know how they fit if they don't know what they are (to be) or we are?" (Researcher Reflection, Final)

Because the students seem to enter our program without an idea about what a science educator is and does, and because of our narrow (and unintentional) focus on science teacher education, there was a mismatch between their identities, and the identities they intended to develop, and sometimes even a conflict between what they saw as the identities of the science education faculty who were available to mentor them. We are hoping to improve the path of this identity development as a science educator by making some adjustments to how we present our program. We will describe changes in our program that we have made from our self study in our discussion section later in this chapter. However, through our discussions, we realized that while we expected them to develop an identity as a science educator, we never painted a picture of what one actually was during throughout this first year. We strove to prepare them to see themselves as part of the CoP of science educator, but did not provide them with a picture of what members of that CoP actually do.

Our Understandings of How to Help Students Negotiate the Path to the CoP

Many of our practices and understandings in transitioning new members into our community are based on the theoretical notions of CoP and identity development. Doctoral programs in science teacher research/education, however, are unique in that we are the teachers and colleagues of these new members. They will not join our program for long; instead taking a position outside our institution but inside our CoP. The students' time in our program is limited to 3–5 years, but they are entering the science education CoP for the duration of their career. To that end, we have established a curriculum aimed at preparing them to take on this new identity over the course of the program. It was not surprising to us that as we reviewed the data we found that our students were very focused on the path through the program. We were surprised, however, at how they were deciphering that path.

One thing that certainly surprised us from the data was the leap-of-faith, in terms of the curriculum, the students felt was required. Although we believed our planned curriculum was well defined, we started to hear doubts in their responses. For example, during one focus group session, the students were asked about obstacles to navigating the path through the curriculum. A discussion ensued that directly revealed such doubts:

> I would say my obstacle is myself trusting the system. I like to know what's coming up, where it's going, and why it is going that way…people have gone through this system and been successful. I just need to realize I will learn things as I need them and not know why ahead of time. I guess I'm trusting the system—that it works; but not knowing every answer ahead of time… (Focus Group, May)

When we brought up the sample checklists and directions we had provided in this first year, they were dismissed with:

> I got the checklists…but, then when I'm talking to people that have been through…I'm like "(sarcastic tone) OK, good luck with that checklist, it is different for every person," I'm just trying to figure out how will it be different for me. Will I be able to do this in the time required, will I be able to figure it out… (Focus Group, May)

This lack of trust did impact the students' actions. For example, another student boldly stated that she did not follow our curriculum noting that she had been told she should not by the more senior students. She stated, "most of the other students have really suggested (a different timeline)" and that she came up with several good reasons on her own to alter the suggested path. When we noted that, although it is good to hear the experiences of other students, they need to carefully consider the type of information they are receiving and whether they are getting it from the most reliable source. With that, the student quietly commented to another student: "We need a checklist for who to ask what" The other student responded, "*You* need to figure that out (both laughing)" (Focus Group, May).

The expressions of doubt prompted us to look closely at our students' actual opportunities, experiences and learning (Posner, 1995). We saw the various voices inherent in that curriculum. We were confronted with the realization that it was not just our planned experiences that made up that curriculum. We realized that the curriculum included the voices of other students; many certainly giving what they felt were words-of-advice; albeit filled with their own experiences and interpretations. For example, one more senior student offered impromptu advice on a forum (the questions were not designed to capture such advice). She told the new students about the experiences they would have throughout the program, and not all of what she reported was accurate. The new students expressed their appreciation of her advice and noted that soon they would be in a position to offer such advice. One new student responded, "Wow! [senior student] you're full of so much information! Thank you for your advice … I am sure I will think of some questions, but for now I am just soaking in everyone's input!" (Forum, September). Another added: "You are full of great advice! Thank you! Maybe in a year or two I will be in a position to offer some good advice too. So please keep it coming!" She did,

> Another thing to remember is that in science education because your minor is outside of education you will not need to take a minor qualifying exam, so it does make sense to be less concerned about taking science courses initially, and enroll in more inquiry courses initially so you can get a jump on doing research sooner. (Forum, September)

We also realized that the curriculum included the voices of other administrators/faculty members. For example our planned activities had the students developing their program of courses in the second semester. The students, however, heard that this was to be done in the first few weeks from one of the associate deans. This advice was rooted in the program in the associate dean's home department. This lead to a great degree of anxiety, distrust that were being advised through the program and mismatch between what the students were seeking and what our program was offering.

It was these experiences that prompted us to take a good overall look at our community. When we tuned into the other voices our students were hearing, we found that the curriculum became very loud and confusing. Our first reaction was to silence the other voices. We noted:

> I am actually surprised that they still listen so strongly to other students when they have been told by advisors and also provided handouts with the information about the process that they will need…It surprises me very much. I don't think it is necessarily bad for students to get information from other students, but it is the inaccurate information that they get that is bad. But we can't really stop them from talking to other students…it is a conundrum. (Reflection Meeting, 3)
>
> I think the distrust came as a result of poor higher communication skills and an uncertainty about who to ask. I think the checklists/review documents have helped. I think that right now we need to listen closely to the things they don't know/the questions they are asking (mostly others) and address them (meaning we need to figure out who to ask) in a booklet. (Reflection Meeting, 3)

During our heuristic analysis, however, we did explore the fact that these other voices are a significant, and perhaps unyielding, aspect of the doctoral CoP. One of the characteristics of a community of practice is a shared repertoire (Wenger, 1998). CoPs develop resources for negotiating meaning over time. In doctoral education, senior students, relationships between faculty and students, stories are such resources for negotiating meaning over time. These things make up a significant part of the enterprise. Thus, we turned our attention to the understandings that are necessary to negotiate this additional layer to our already complex community. In doing so, we realized that much of the confusion in the noise was more of a reflection of the lack of understanding of our CoP or the identity of a science researcher/educator; for it is the qualities/competencies of the persons in this community that are ultimately being assessed. It was clear to us that what we thought we were teaching was being overshadowed by other components of the CoP. For example, the students negotiating amongst themselves about how early a person can complete the field paper component of the portfolio revealed a lack of understanding that this paper demonstrates that they are an expert in a field of study and able to synthesize current theoretical and empirical understandings to identify the themes, gaps and strengths of current work in that area. Instead, the students discussed it as a 30–40 page document summarizing the research that has been done on a topic. The latter can be done in the first couple of semesters; the first is an individualized process that typically takes considerably longer.

Our Distinction Between Reified Standards and Competent Engagement

Looking at our CoP as a process that includes a shared repertoire, we realize that many of the associated resources, understandings and standards are negotiated in practice. The process is generative, pushes the community forward, and constraining,

keeps it in check (Wenger, 1998). We entered this self-study process believing that our program was appropriately balanced in terms of the generative/constraining aspects. We believed that our curriculum invited new ideas as much as it sorted them out. Our findings, however, prompted us to question if the generative and constraining process inherent in our curriculum was, in fact, appropriately balanced. Specifically, our initial analysis prompted us to question whether the students were being allowed to challenge the curriculum while we were working to hold them to the necessary standards of competence.

Our analysis revealed three challenges to our curriculum, as well as how our community was/was not responding to them. The first major challenge, of course, is explored above. The students challenged the boundaries we had established around our science education program. For the most part, our curriculum was designed to respond to the challenge and changes are currently being made that will allow it to respond even more thoroughly. In addition to this challenge, however, we also 'heard' challenges to the inclusiveness and work/life balance of our CoP.

An important component in teaching and learning experiences is self-questioning, self-doubt, and disappointment of expectations (Kerdeman, 2003). Hans-Georg Gadamer (as cited in Kerdeman, 2003) describes this as "being pulled up short" (p. 295). Much to our surprise, our CoP was "pulled up short" with our second major challenge—inclusiveness. Although our CoP has made great strides in terms of gender representation, we have not made the same progress in terms of racial representation. At the time of the study, we had an approximately equal number of male and female students, as well as students from many different countries, but only one woman of color. Over the course of the first year, she made a few references to underlying racial discrimination found in the periphery of our community and a sense of exclusion from the student social interactions inside the CoP. She expressed that it was not a single person or persons that made her feel excluded, but the community overall. In one focus-group session, she addressed her feeling of being excluded in the social community of students, telling the other students:

> I feel like being a Black woman disconnects me from this space. I see you guys all socialize together, but it's like "Where am I?" I'm not present. You guys hang out and help each other. And I think part of that has to do (pause) maybe with preconceived notions…but, I go to other places, other departments and I socialize well…when is the last time anyone here in this department had to interact with a Black woman? When did they have to talk to a Black woman? So, maybe there are apprehensions about interacting with me? Maybe even there are preconceived notions or assumptions…So, I think it is really hard for me to put myself out there and socialize with the group. Just because of that—the interactions that I do have. So, in some ways I feel really, really excluded. (Focus Group, May)

The others noted, "I think I sensed that [you] felt excluded. But, I don't think it is our intentions to make you feel excluded in any way." She noted that she didn't feel it was intended or on an individual basis, but by the decisions that are made by the group on what to do and who to talk to/invite in regards to social interactions (Focus Group, May).

Later, we reflected on her comments:

> It surprised me that [she] was feeling so disconnected from the other students. It also surprised me that she was willing to state it to them and confront them. It surprised me because I was a) unaware of it, and b) I don't believe I would have been able to do the same thing in the same gracious way that she was able to do it. She seemed so calm, yet serious and non-accusatory—she was simply sharing her feelings, and not really putting blame on others. I would like to try even harder than I believe I already do to help all students feel connected to the program; yet I am not sure how to help them feel more connected to one another. (Reflection Meeting, 3)

We discussed the understandings inherent in our CoP that fostered such feelings. As a full-time doctoral program made up of individuals who left jobs and families behind, our doctoral students do tend to develop a family structure. We were hearing from one member who saw that structure and understood that she was not a part of it. We understand there could be others now or in the past that didn't have (or take) the opportunity to express such feelings. This prompted a lot of discussion as to what actions we should take in regards to the students' personal relationships. To complicate the discussion even more, it was occurring at the very same time as the work/university balance issues (explored below) came to light that emphasized the need for us to refrain from intruding in the graduate students personal lives. Thus, we wondered if it was our place to intervene in regards to the social life of our students (fearing that would be too much control). We felt a huge conundrum of what we should do to intervene, and even whether to intervene—surely we needed to do something to ensure all students felt part of the CoP. But, we soon realized:

> After reconsidering what the doctoral students said, I realize that I have been thinking about what we should/shouldn't do—not what we do (unintentionally). By turning the "socialization" over to the more senior doctoral students, we are allowing the problems inherent in society into our program…this is their social lives—however, we need to structure it to be more inclusive. Perhaps by making it an official committee, we are making someone(s) responsible. (Reflection Meeting, 3)

Our discussions quickly turned to what actions we will take, which prompted a lot of reflection, some changes to the curriculum, and a lot of questions to pursue as we delve into the complexity of the understandings in this area and how they are/should influence the curriculum. Our understanding and practice in regards to the equity aspects of our CoP need further adjustment. At this point, we do know that our community was able to 'take' the criticism gracefully and seriously. There is an obvious desire of the community to be inclusive. That approach to responding to students' concerns should be maintained. Addressing these weaknesses regarding our own understandings of how this is affecting and being affected by our practice will take much more time and effort. This will be explored in the full 5-year self-study.

The third challenge we found to our curriculum involved the work/life balance issue that plagues much of higher education. Although the new students appeared to figure out a balance that was a good fit for them and their families throughout this first year, the fact that this was found to be significant to all the students prompted us to explore this issue and the aspects of our curriculum that allowed resolutions.

Throughout the first year, the new students made comments such as:

> My obstacle is more of the balance between this space and my world outside. My world outside is more important to me than this space, I think, not that this isn't important to me. So, its continuing to keep that balance…the more I start focusing on this and letting things go outside of this—the fun just starts plummeting. (Focus Group, May)
>
> I think some for me, it is a challenge to be in school, a mother, a new wife…I understand there are consequences… I don't feel like I socialize, just into the science education department in general, part of it, because I think there are lot issues with me trying to navigate this space because I don't really fit in…by my standards, to the group. (Focus, May)

As we reviewed and reflected on the data across the entire first year, we found that the students figured out a balance that suited them and their families. We found that our curriculum allowed for the compromise in the following ways:

> In regards to family versus work, I continue to think that we do a good job… the students are figuring out ways to achieve this balance (our program is allowing for it). These include the ability to take time off (as long as they work hard while they're here) and the ability to focus the work during traditional working hours (while kids are in school). We don't make a point of making them prove they're committed by scheduling unnecessary things that would intrude on their personal time. We schedule our tasks/expectations during the workday. I know there's a lot, but that is the nature of the level of education they are at. The problems come up when they allow themselves to get behind or take the stress home. They may procrastinate on their work and let the stress affect every aspect of their life. (Reflection Meeting, 3)

Realizing how to achieve a work/social life balance is critical as these students take their places in our CoP. These are important aspects of our curriculum that allowed them to work through this issue on their terms. These aspects need to be maintained as we consider the practical implications from the overall study. This ability is largely modeled by the science education faculty, who work specific hours each week, and who also have fulfilling and active home lives.

Discussion and Implications: Changes to Our Theoretical and Practical Understandings

What we are describing in this chapter is, of course, not our full program or our students' entire experience. We are sharing what challenged our own understandings of how we support new members as they transition into our science education CoP. Also, we recognize that the first year is a transition year. All of the students are transitioning from a former identity and career to an identity of a science education doctoral student, and ultimately an identity of a science educator. Their perceptions of this transition are valid, and whether or not they prove to be accurate portrayals of the field or our program, or match our own, are still perceptions that influence their transition into our science education CoP.

Fostering Legitimate Participation in Our COP

Regarding changes in our understandings of how we support students as they join the larger science education CoP, we have several that were especially challenging for us. First, we were surprised to realize that we had unintentionally built boundaries around our CoP that supported future K-12 science teacher educators, but did not provide the same support for those who did not intend to prepare teachers for formal K-12 classrooms. As both the teachers and old-timers in the CoP, our intention was to foster a smooth transition for all of our students. However, we realized the structure did not make broad connections to the full field of science education, leaving some students feeling disconnected. This finding is similar to the Discourse identity described by Gee (2001) in which we believed our discourse with our students was helping all students, and yet it did not support all students in the way we intended. Second, we were surprised by how our students' participation in peripheral communities supported their participation in our own. In many ways, these other communities allowed our science education CoP to develop a dynamic discourse that was addressing diverse needs. Unknown to us, this discourse was helping us to avoid the consequences of those noted unintentional boundaries.

Third, we were surprised to realize that one of our students, the first Black female that has enrolled in our science education doctoral program (at least under the current faculty), felt excluded from the social interactions within the CoP. This is a tricky balance, because we realized from the other students' responses that the exclusion was unintentional—this was not purposeful and intentional discrimination. However, for us not to question the current structure and practice or intervene is not acceptable. The question becomes how much do we intervene, given the discrimination was felt during social activities. How much really can we, or should we, influence social activities? We realize that students who come to us as doctoral students are adults, with personal lives, and we are unsure of how much influence we should actually have on these personal lives. This is particularly problematic given the work/social life balance concerns of the students. Should we be influencing how they spend their time away from work, and with whom they choose to spend this time? And if so, how do we do this? It seems that to develop a healthy CoP that builds on social constructivist theory we need to focus, in part, not only on the practical work of science education, but also on the social interactions that aid in the development of such an identity (Vygotsky, 1978, Wenger, 1998). Perhaps some of the historical precedence (continuity) needs to be shared to better enable feelings of inclusion by all members (Giddens, 1979).

How Our Structure Supports Identity Formation

Through this self-study we also realized that though we intended to help our students develop identities as science teacher educators, our structure could be more effective in enabling this development. We were unaware that students came to our program without a solid conception of a 'science teacher educator,' and though we formally and over time asked them whether they believed they had become a science teacher educator, we really never helped them to define what that meant, and how they would know they had become one. Of course, all identity development is bumpy, and not straightforward, and indeed, no identity is done. In essence, all science educators and science teacher educators continue developing their identities over the course of their careers, with continual solidifying, change, and modification in how self is viewed and how others perceive one. This continual development is common with all identity development (Gee, 2001) and it should not really surprise us that they did not develop one identity as a science educator. In fact, it may have been more realistic for us to consider how they transitioned from one career to science education doctoral student on the way to becoming a science educator, because simply transitioning from one role to a new role is a big change in identity. Furthermore, the challenges students had in developing an identity should not be surprising given all identity development is difficult (Packer & Goicoechea, 2000). The institutional perspective of becoming a science educator develops over time with those who have already taken on the identity of a science educator (e.g., faculty) and who try to support others in their own identity development. This support often takes place through discourse and dialogue, and in our case this discourse took place not only orally, through focus group meetings and private meetings with individual students, but also through written discourse in terms of checklists and written information provided to the students. There was also discourse that took place outside of the direct science education CoP in terms of providing erroneous information, as well as erroneous information provided to new students from returning students. The process of sifting through information, engaging in discourse with different members in the CoP and members in the periphery contributed to the new students' development of identities as science educators and researchers (Danielewicz, 2001; Gee, 2001, 2005). Furthermore, we came to realize that although we have developed a procedure for assessing the qualities of science educators and researchers with tangible outcomes or milestones, we have not taken the time to convey the nature of that identity that necessitate these outcomes and timelines. Such an understanding, we believe, would help the students explain and negotiate the existence of multiple paths and voices found within our CoP.

Implications of New Understandings on Practice

Based on the findings of the self-study, we developed a list of four aspects of the nature of our CoP that fostered some of the confusion. The aspects of our program that need to be conveyed to eliminate the confusion we noted include:

1. Our community has a necessarily high degree of individualization. Our CoP is structured to allow individuals to become experts in their lines of inquiry. Although there is an apparent level of uniformity in regards to seminars and portfolio requirements, these also have a degree of flexibility such that they can be tailored to accommodate a line of interest as well as new ideas. This level of individuality requires a high degree of self-monitoring and goal setting. Attempting to mirror the path of others is frustrating in such an environment, and may not lead to attaining individual goals.
2. Our community is multi-disciplinary and multi-departmental. By its nature, our CoP is a complex system. In addition to the peripheral communities added to enhance our students place in the CoP, there are levels of administration and various policies within the community. These various components of our CoP, as well as the peripheral communities, have additional requirements and different practices. For example, the experience with the associate dean conveying the experiences of her home program. The students need to work through these levels and the required vs. recommended procedures involved.
3. Our community has tentative aspects. Although many of the traditions and expectations inherent in the doctoral program community predate the faculty, there are also changes that occur on a continuous basis. For example, economic or political influences on the profession precipitate changes in our program.
4. Our community has high expectations for all of its members. Our checklists may convey an understanding of tasks that can be completed in a short period of time to be checked off and stories may support such a notion. That is not an inaccurate portrayal of the process. The 'tasks' are products demonstrating professional experiences and competencies within our CoP. For example, research papers are a reflection of the research experience.

In thinking about these aspects of our program, we have been considering what kinds of changes we can make in our approach to supporting students in developing identities as science educators and becoming part of the broader CoP of science education. It is clear to us that one major change that we should make is to revise our readings and course assignments to focus on the science education field at large, not only on formal K-12 teacher education. While we try to make our program flexible enough for all who wish a degree in science education, we tend to focus on K-12 teacher education, and need to think more broadly about informal and higher education.

Another change we are considering implementing is a focus on identity and identity development. We would like to explore whether sharing the research on professional identity development would help our students not only navigate their

development toward thinking of themselves as science educators, but also see that the struggles and discomfort that they may feel during the process is common with any identity development.

While we are unsure of what our role should be in terms of intervening into social aspects of the doctoral student experience, we believe we should make more formal efforts to contribute to all members of our CoP being included in science education social events. Of course, when we ourselves hold social events for our science education program, we invite all members. We are still considering the most appropriate intervention aimed at including all students in the social structure of the program. This item relates to the next two, which are to continue research into inclusiveness of the program and also work/social life balance issues. While we believe that our program is inclusive, future research through self-studies may highlight ways we can be better inclusive, and to support our students in being more inclusive themselves, and among themselves.

This inclusiveness also relates to work/social life balance. Indeed, the social aspects of doctoral students should be personal, and it seems that we are also obligated to not only support the work/life balance of our students, but also to contribute to their identities as being inclusive, further helping them to recognize the broadness of the CoP to which they will belong, and also the broad varieties of people who are part of the science education CoP. We believe we should include discussions on work/life balance within our proseminar. Again, we also believe we need to provide more opportunities for social events that include all science education doctoral students, which may enable students from many walks of life to get to know one another, and then actually be more inclusive in the student-organized social events that include only students and not faculty.

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