Creating an Equitable Classroom Environment

A Case Study of a Preservice Elementary Teacher Learning What It Means to "Do Inquiry"

Elsa Q. Villa & H. Prentice Baptiste

Introduction

It is widely accepted, as attested by the National Science Standards, that inquiry pedagogical methods are most effective in teaching science (American Association for the Advancement of Science [AAAS], 1993; National Research Council [NRC], 1996). Such classroom environments are sites where learners do inquiry as defined by the NRC (1996):

> Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known . . . using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. (p. 23)

Yet, the challenge for most, if not all, science teacher educators is to instill in preservice teachers a conceptual understanding of what it means to do inquiry as a pedagogical method (Bonnstetter, 1998). The motivation for this is to create equitable classroom environments where children can thrive through investigations where they can make sense on their own rather than relying on teacher-directed knowledge. This is especially imperative for minority children, who tend to be in classrooms where the emphasis is on basic skills (Sleeter, 2005) or where a phenotypic appearance may further subject them to discrimination or bias, which may affect their educational experience, as noted in Monroe (2013).

We discuss a case study of a preservice teacher who participated in a two-semester course sequence of elementary science and mathematics methods spanning one academic year. These two courses were taught by the first author and embedded a pedagogical approach grounded in inquiry methods. That is, at the outset of the courses, preservice teachers were asked, "What is inquiry?" Most, if not all of them, were unable to answer the question.

This set into motion the objective in the methods courses for these preservice teachers to actively engage in an investigation of inquiry as a pedagogical method. In this article, we show how the preservice teacher in this case study developed deep conceptual understanding of what it means to do inquiry, especially with special needs children and English Language Learners [ELLs], through social and cultural participation in a process of investigating, analyzing, and synthesizing the meaning of inquiry teaching.

The purpose of this study was to follow the learning trajectory of a preservice teacher in developing her understanding of inquiry as a pedagogical method. The research question driving this study was: What mitigating factors, if any, mediate how a preservice teacher re-shapes her understanding about what it means to be a teacher?

Using Vygotsky's (1986) socio-cultural theory of learning as our theoretical framework, what we found were several components critical to the learning process: (1) Cultural artifacts play a role in mediating learning; these artifacts include commercially produced inquiry materials and children's positive reactions while engaging in scientific inquiry; (2) analysis of and reflection on these cultural artifacts contribute to making sense of what it means do inquiry; and (3) synthesis of meaningful relationships among the various artifacts contributing to transformational thinking, i.e., learning what it means to do inquiry.

Background: Challenges in Teacher Preparation

Teaching inquiry methods can be a daunting and elusive task for many teacher educators. As aforementioned, we argue the primary challenge may be preservice teachers' embedded conceptions of what a teacher does and how a teacher acts, notions strongly resistant to change. In his sociological study of teachers, Lortie (1975) coined the term "apprenticeship of observation" to describe the close contact of prospective educators with their own teachers and professors during their sixteen plus years of formal schooling (p. 61).

These experiences, with its myriad of social interaction and activity, shape teachers' understanding of what it means to teach and learn. This socialization is further influenced by field experiences while in their undergraduate program of study (Darling-Hammond & Bransford, 2005; Darling-Hammond, Hammerness, Grossman, Rust, & Shulman, 2005; Lortie, 1975; Oakes & Lipton, 2003; Zeichner & Gore, 1989; Zeichner et al., 1998).

Thus, the tendency for preservice teachers is to embody an understanding of teaching as transmitting knowledge from teacher to student through direct instruction rather than creating an environment where learners generate their own knowledge through exploration and investigation. We use the term embodiment to imply a deep understanding of what it means to do inquiry, a challenge for pre-service teachers who tend to teach the way they were taught (Lortie, 1975).

This embodiment may explain why teaching inquiry methods can be a struggle,

Elsa Q. Villa is a research assistant professor in the College of Engineering at the University of Texas at El Paso, El Paso, Texas.
H. Prentice Baptiste is a professor in the Department of Curriculum and Instruction of the College of Education at New Mexico State University, Las Cruces, New Mexico.

as attested by both Newman et al. (2004) and Hayes (2002) in their studies of elementary preservice teachers learning about and teaching inquiry-based science. Preservice teachers' classroom experiences tend to be teacher-centered, which challenges teacher educators in their effort to overcome this tendency.

This tendency is further evidenced in Windschitl's (2004) study of preservice and in-service teachers of science. Windschitl posited that a prevalence of teachers hold folk theories or spontaneous theories acquired from formal and informal schooling experiences. These theories tend toward pre- and mis-conceptions about pedagogy and content, further contributing to the challenge of teaching authentic inquiry practices in the science classroom vis-à-vis the aforementioned definition.

Despite studies claiming preservice teachers' learning of inquiry methods (Fernandez, 2002; Smith, 2007), other studies show the strong tendency of preservice and novice teachers to revert to traditional ways of teaching in spite of their preservice teacher educational practices to do otherwise (Crawford, 2004; Flores, 2006; Rosenholtz, 1989). Furthermore, many studies focus on preservice teachers and methods to counter direct instruction (Cochran-Smith, 1991; Feiman-Nemser, 2001; Loughran, 2002; Newman et al., 2004; Singer & Moscovici, 2008), yet do not address if and how preservice teachers' reify what it means to facilitate learning where students generate their own knowledge rather than be the source of knowledge for their students.

Theoretical Framework

Vygotsky (1978; 1986) recognized the significance of social and cultural experiences in constructing knowledge in the process of learning, and postulated learning as a heuristic and developmental process in which individuals make sense of phenomena, i.e., develop conceptual understanding through investigation about the relationship of objects, events, and experiences. The learner makes meaningful connections among and between these seemingly disparate objects, events, and experiences through critical reflection and discourse or, as Vygotsky (1986) stated, "[the act of] studying *real* concepts in *depth*" (italics in original, p. 161).

This developmental process is nonlinear and spiral in nature as the learner re-visits familiar spaces with new understandings that result in transforming their interpretation of those spaces. Brown, Collins, and Duguid (1989) describe this process in the following:

> A concept will continually evolve with each new occasion of use, because new situations, negotiations, and activities inevitably recast it in a new, more densely textured form. So a concept . . . is always under construction. (p. 33)

Thus, learning occurs in phases where at first the learner is exposed to a seemingly disparate array of objects; and, through investigation of the interconnectedness of these objects and mediation of cultural artifacts and discourse, finds strands of commonality among them that initially results in pre-concepts. As more meaningful connections are made about the relationship of these objects, "germinating seed[s] of a concept" are formed (Vygotsky, 1986, p. 123).

Teaching methods courses to preservice teachers should be informed by this theory so as to (1) transform belief systems from ones tending toward teacher-centered classrooms; and (2) develop an understanding of how children learn to inform instructional decisions. Thus, if children are struggling to understand concepts, an informed teacher can make necessary adjustments in their instructional delivery and classroom experiences.

Once a learner has made meaningful connections, Vygotsky posited these connections contribute to deeper understanding when learners engage in critical reflection and discourse with peers and experts to scaffold what is known with what needs to be known. Deep understanding occurs when the learner synthesizes relationships among the objects through abstractive reflection and sees this relationship as a unified concept without any direct reference to a single object.

Vygotsky (1986) stated, "in genuine concept formation, it is equally important to unite and to separate: Synthesis and analysis presuppose each other as inhalation presupposes exhalation" (Vygotsky, 1986, pp. 135-136). In this paper we will see how our case study subject engaged in critical reflection and came to understand what it means to teach and learn.

Motivation for Study

The four-year, public institution in which this study took place is located in a predominantly Hispanic community on the U.S./Mexico border. At the time of the study, preservice elementary teachers would enroll in their mandatory elementary mathematics and science methods courses during their last two semesters of undergraduate study while contemporaneously in their field experience in these two semesters, i.e., student teaching. During the mathematics methods course semester, preservice teachers spend nine hours in the field; during their last semester, they spend 18 hours in the field.

The first author had been teaching these mathematics and science methods courses for several years, and specifically focused on inquiry as a pedagogical approach. Typically the same cohort would enroll into these courses for two consecutive semesters. After the first couple of years of teaching these courses, first author realized that between 15 and 20 percent of the preservice teachers in her science methods classes seemed to transform their thinking of what it means to teach and learn, as evidenced by their comments during classroom discussion and in their final written reflections for the course. This study was conducted then to understand if indeed transformational thinking was occurring and, if so, to identify contributing factors causing this transformation.

The pedagogical approach used in each method course consisted of several components:

1. Self-selected teams of two to four students taught a series of four consecutive lessons from commercially-produced kits such as *Investigations in Number, Data, and Space* (http://investigations.terc.edu/) for the mathematics methods course, and FOSS (http://www.fossweb.com/) for the science methods course.

2. Teams engaged in a lesson study process following each lesson, a process originating in Japan in which peers observe each other teach in turn and debrief each lesson soon after it is taught (Wiburg & Brown, 2007).

3. Students read scholarly papers, such as *How People Learn: Brain, Mind, Experience, and School* (Bransford, Brown, & Cocking, 1999), *Shifting from Activitymania to Inquiry* (Moscovici & Nelson, 1998), and *Situated Learning and the Culture of Learning* (Brown, Collins, & Duguid, 1989).

4. Students wrote reflections on these aforementioned scholarly readings and were expected to connect these readings to what they were experiencing as student teachers and as teachers of inquiry, which often were dichotomous.

5. Informal classroom discussions led by the instructor centered on the aforementioned scholarly readings. It is important to note here that this particular pedagogical approach does not presume this

approach is exemplary, or the only mechanism for teaching inquiry methods.

To clarify why commercially produced materials were chosen as a major pedagogical component, the next section provides contextual background.

Contextual Background

This section provides a brief background on the historical perspective of the commercially produced elementary inquiry materials used as the source of teaching materials for the study.

Inquiry-Based Materials

For more than 50 years, science and mathematics educators have focused on reforming how these subjects are taught and have ascribed to an inquiry-based approach as the most viable means for teaching and learning science and mathematics (AAAS, 1993; NRC, 1996). In the late 1950s, psychologist Jerome Bruner and other distinguished scholars in education, mathematics, science, and history came together to examine science education to create a vision for improvement.

Bruner (1960) summarized his impressions of this summit in *The Process of Education: A Landmark in Educational Theory* in which he theorized education as a process rather than a collection of disconnected facts. He characterized curriculum as spiral, i.e., building on learners' ways of knowing about the world using naturalistic ways of thinking. This is reminiscent of Vygotsky's (1986) theory of learning whereby learning happens through a non-linear and spiral process of cognitive development.

Throughout the decade of the 1960s, many scholars in science and education collaborated to develop hands-on, inquiry-based curriculum with support from a variety of public and private sources. One notable scholar of that era Robert Karplus recognized the significant role of the learner, as attested by Bruner's (1996) description of Karplus as someone

> . . . who knew that science is not something that exists out there in nature, but that it is a tool in the mind of the knower—teacher and student alike . . . There are lots of different ways of getting to that point, and you don't really ever get there unless you do it, as a learner, on your own terms. (p. 116)

Karplus recognized the vital role of the learner as one who actively engages in the process of learning and generating conceptual understanding.

As a result of these early efforts, various organizations produced high quality inquiry science and mathematics curricula for elementary schools, and continue to do so. These include the Lawrence Hall of Science at the University of California at Berkeley and its Full Option Science System [FOSS], the National Sciences Resource Center [NSRC] at the Smithsonian Institution and its Science & Technology for Children [STC], and TERC and its Investigations in Number, Data, and Space for inquiry mathematics (http://www.terc.edu/ourwork/elementarymath.html).

Yet, in spite of these exemplars and wide support for implementation, many, if not most, school districts adopting these materials quickly abandon them through either one or a combination of the following: neglect of materials management, paucity of continuous and ongoing professional development, and/or lack of administrative support (Bonnstetter, 1998; NSRC, 1997).

We argue that another factor may be the ingrained ways of knowing what it means to teach--teaching as direct instruction and learning as the consumption of teacher-delivered knowledge rather than teacher as a facilitator of learning and learner as a generator of knowledge (Apple, 1979; Eggen & Kauchak, 2006; Freire, 1970, 1998; Van de Walle, 2004).

Method

Our investigation used the naturalistic approach of qualitative research, as such research seeks to better understand, illuminate, and interpret the multiple realities of research participants through its acquisition of rich descriptions of their experiences (Lincoln & Guba, 1985; Merriam, 2009). Our study was phenomenological in nature as we focused on the essence of the experiences of preservice teachers who were making sense of inquiry pedagogical methods (Merriam, 2001).

Because we were interested in understanding the process of learning, we chose case study method since "case study is a particularly suitable design if you are interested in process" (p. 33). Moreover, case study is a method employed to gain more information about a particular phenomenon because it provides vivid material to chronicle the events leading to transformative thinking.

For this article we selected one case from a larger study of 19 participants. All 19 participants in the larger study were female: Eight were Hispanic Americans, one was African American, one was Japanese, one was Mexican, and one was Irish. Purposeful sampling was the technique to select participants (Merriam, 1988; 2009), and the criteria for selection was evidence of interrupted thinking derived from what was said during class discussions and what was written in scholarly paper and personal reflections.

Of these 19 participants, five had taken only one course (mathematics methods) with first author, and analysis of data derived from these five indicated that their thinking was interrupted rather than transformed. That is, these students were experiencing a difference between how children reacted when the preservice teachers taught their inquiry lessons and how children reacted during regular instruction by the lead teacher in their field classroom.

We provide the following excerpt to illustrate what we define by interruption: "I just realized how really you got to let the kids manipulate [the numbers]." This quote suggests the importance of allowing children to use various strategies in solving problems. While this is an important element of inquiry methods, this manner of thinking was the closest this particular participant came to providing evidence of an understanding of inquiry methods.

The remaining 14 participants took both methods courses back-to-back with first author, who employed the same pedagogical approach in both courses. Of these remaining participants, two indicated interruption rather than transformation, and analysis of data of the remaining participants indicated transformative thinking. For example, one stated:

> When you teach traditionally, that's all that you know. That's your world. [As a result of these courses,] you've been, in a sense, awakened and you have that responsibility now . . . You're accountable because you have this extra knowledge. You have knowledge of social justice issues. You have knowledge that go way beyond the classroom.

Dani was selected as the case study for this paper because her data provided a more "intensive and holistic description and analysis of a single instance" of the phenomenon under investigation (Merriam, 1988, p. 21), and "a single case or small nonrandom sample is selected precisely because the researcher wishes to understand the particular in depth, not to find out what is generally true of the many" (emphasis in original, p. 208). Further, the single case allows us to closely follow her thinking as she begins to transform her thinking.

Setting

The university in this study is a public regional four-year institution located on the U.S./Mexico border with demographics representative of those in the community: Approximately 80 percent are Latina/o. In the undergraduate elementary education program at the university during the time of the study, approximately 99 percent of the students were women. This study focuses on learning as a process of cognitive development of a preservice teacher learning what it means to do inquiry, and also focuses on how this understanding can potentially impact the lives of children who are culturally and linguistically diverse or who may have institutional markers, such as ADHD.

Research Design and Participant

As already mentioned, we used a single case study in this article as this case elucidates the process by which this particular participant transformed her thinking of what it means to do scientific inquiry (Merriam, 2001). Case study allows us to understand an individual's experience from their perspective to "evaluate, summarize, and conclude . . . [and to increase] its potential applicability" (p. 31).

The case study participant Dani, a pseudonym for this single woman, was in her early 20s and self-identified as a Latina. She was in a cohort of 30 preservice teachers who took the aforementioned set of methods courses together during the last two semesters of their undergraduate studies. During these two semesters, Dani was a student teacher in a third grade class with the same female teacher in both semesters.

What is interesting to note here is that Dani was not identified as a study participant until the last day of her final semester. Her written reflections and contributions to classroom discussions in both the mathematics and science methods courses were not indicative of what she was apparently experiencing over these two semesters. On the last day of the science methods course, Dani had a lot to share with first author since she had just experienced her transformational moment. It was on this day that she was asked to participate in the study.

Data for the study were collected through focused, in-depth interviews (Seidman, 2006) Seidman's (2006) that consisted of three separate interviews for participants to make meaning of their constructed world and their place in that world. A week separates each interview to allow the interviewee time to reflect and organize their experiences. To analyze the data, salient themes were identified in the coded data using a constant comparative method in which themes are compared and categorized using an iterative process of comparison and reclassification, as needed, to refine the categories in addressing the research question (Glaser & Strauss, 1967; Strauss & Corbin, 1998).

Role of the Researcher and Researcher Bias

Because the first author was the individual who conducted this study and was the instructor for these methods courses, this section problematizes her role as it has potential for bias in various aspects of the study. As a Latina, the first author was fully aware of the influence of her values, beliefs, and experiences in her interpretation of what she saw, heard, and read (Peshkin, 2000; Siddle Walker, 1999).

Furthermore, as the former professor of the research participant, the first author was conscious of her own subjectivity and influence of power during interviews, and strived to not influence responses and, for this reason, conducted all interviews after the participant was no longer a student in her course. As Guba and Lincoln (1989) note, participants also contribute to and influence the inquiry since it is their story that evolves from the context of the inquiry.

Data Analysis

Using Vygotsky's (1986) theory of learning as a framework, we analyzed data from the case study to identify how cultural tools mediated learning of what it means to do inquiry. Using a constant comparative method (Glaser & Strauss, 1967), we identified the cultural artifacts as the commercially developed inquiry curricula, observation and dialogic interaction using a lesson study process, children's knowledge generation, and children's academic discourse. These were locally positioned factors that contributed to Dani's analysis and eventual synthesis of these seemingly disparate experiences.

Cultural Artifacts for Mediating Learning

Inquiry curriculum. The role of the inquiry curriculum as a cultural tool in this study was central to mediating understanding of inquiry methods, as it was the medium to create an environment for investigating the phenomenon of inquiry as a pedagogical method. Our data from the larger study indicated that some of the preservice teachers would modify the teaching activities in spite of explicit directions by the instructor to follow the teacher guide with fidelity. Imposing other pedagogical schemes has potential to interfere with the nature of the inquiry method.

For example, our anecdotal experience informs us of how some preservice teachers would give children vocabulary words and definitions to be copied into a student journal, an action atypical of inquiry methods. Rather, students should uncover the concepts connected to these words during engagement in their investigation to develop appropriate scientific discourse (see Gee, 2005). These instances are further evidence of the ingrained notion of the teacher as the center of classroom activity rather than learner.

At the outset, Dani was conflicted after reading the teacher guide, as this did not fit her preconceived model of teaching and learning:

> At first I was really confused. When I read the inquiry lesson plans, I said, "How is this going to work?" It was kind of weird to me . . . I'm standing in the classroom and looking around, I'm like, Well, there's not much that I say. There's not much that I do." And I'm just kind of observing them and guiding them. You know, I was just there, and it was just weird to me 'cause like I said, in *my* internship classroom, it's more like, "Follow this." And with these lessons, it wasn't like that at all. The kids were on their own . . . Wow. This is possible?

This conflict is expected given the orthogonality of inquiry method with preservice teachers' own experiences as typical classroom learners who surmise teaching as direct instruction. This is further reinforced by their experiences in the student teaching classroom, as shared by Dani in the following:

> [The way my internship teacher would teach math was] like spitting back a product. It's kind of like, instant results. "I need to see the product now." I saw her as more like, "Can you mimic what I do?" or "Can you complete the procedure?" rather than "Do you fully understand why this is the way that it is?" And with the inquiry lessons, the kids understood why you collect the data and how you organize it. They got a more rounded picture of it instead of, "Oh, you're *going* to collect it. You're going to collect it." Not "*why* are you going to collect it?" That's what I saw, you *are* going to do this as opposed to *why* are you going to do this.

Dani followed the teacher guide with

fidelity, and this allowed the inquiry pedagogical method to unfold for Dani as children became actively engaged in their investigations.

Observation and dialogical interaction. As mentioned earlier, a lesson study process was used and entailed both observing a group of children and taking field notes on children's motivation, academic, or social behavior. In this process, a debriefing session among the team members follows each lesson as team members dialogically share their observations of students and of the teaching. Dani described her experience as an observer during one of the inquiry lessons:

> At the beginning, you had some kids talking in the back. Then *all of a sudden*, one raises their hand and, "Oh, this." And they start getting involved, and the others look around and, "Oh, what's going on?" And then they start to get interested, and that's when hands start flying up in the air. And kids are really excited to start talking. That's one of the things I noticed right away . . . [So as an observer,] that's something completely different than when you're standing up there and doing it yourself . . . I particularly paid attention to: How were they interacting now? What was the dialogue then? [Reflecting back on that lesson as an observer] and watching someone else teach, I could focus more on the interaction of the students, and the way they were reacting to her.

Dani is engaged in the inquiry process as evidenced by her generation of questions as she begins to make connections between what she was witnessing and the inquiry pedagogical approach. Her insight demonstrated the potential for lesson study as a vehicle for active reflection.

Children's reaction to inquiry method—witnessing knowledge generation. During the mathematics methods course, Dani and her team co-taught a series of four consecutive mathematics lessons from *Investigations* curriculum albeit a portion of an entire unit. They taught these lessons to ELLs in a bilingual classroom, and Dani described the children's reaction:

> Even with that little barrier [of being a bilingual classroom], it didn't stop [the children] from doing what they were supposed to do and from the results that we were supposed to be getting . . . [The children] were really excited, and they were just learning. I guess that's the way to put it--they were learning. They were doing it by themselves. There was nobody, I mean there was a facilitator obviously, but nobody telling them this, this, and this. It was kind of like exploration, I guess, is a good way to put it.

Dani witnessed children's excitement and learning as they generated their own knowledge with assistive facilitation of the inquiry pedagogical method. As a cultural artifact, the children's reactions to the lessons were particularly significant in that this was a bilingual class taught in English. By the end of the mathematics inquiry lessons, Dani realized that children were fully capable of generating their own understanding without direct instruction:

> By the end of our lessons, the children were still just as engaged as they were during the first lesson. They were really into it . . . [When I asked them to explain what they had done, they said things like,] "I collected this data, and I recorded it this way" or "I used tallies, right?" or "I used a table" or "I put it in on this graph so that we could see this, and this, and this." And the way they were explaining, I said, "Wow! They really *did* get it, and I didn't tell them." It was "You collect data because of this. You collect data like this. You're going to graph it like this." They were able to stand up there and tell me by themselves. I didn't sit there and say, "This is why we do this." They came up with it on their own.

The children's explicit display of understanding may be one of the more powerful cultural artifacts influencing development of conceptual thinking about what it means to be a teacher. This is closely coupled with children's academic discourse, particularly for the borderland community in which this study was conducted as many children are learning English as a second language.

Children's reaction to inquiry method—academic discourse. When Dani commenced her mathematics inquiry lesson, she had doubts that children would stay on task. Then she began to hear academic discourse.

> And I thought, "Well, are they going to be messing around? Are they going to be playing? What are they going to be doing?" And, as I'm walking around, I can hear the kids saying, "Well, we could use a bar graph for this" or "We could use a pictograph for this." They were using words that I hadn't told them; they were doing it on their own.

Dani's own inquisitiveness marks her engagement in the process of learning inquiry that is further influenced by the social interaction of the children, as Vygotsky (1986) predicted.

When Dani taught the science lessons the following semester, she again noted the use of academic discourse during the FOSS lesson on the human skeletal system:

> [By the end of the lessons, the kids were finding] little claws of the rodent in the owl pellet. And then one of the little girls comes up to me, and she says, "Well, look! There's a phalange right here. Are these phalanges, too?" She puts her fingers out. "Yeah, that's exactly right." And then I'm walking around, and I'm hearing like, "Oh, I found part of the vertebrae." And things like that. I hadn't even introduced vocabulary. The words were on the worksheet we had given earlier, but they were making those connections themselves.

These various cultural artifacts afforded opportunities for dialogic engagement among Dani's peers as they debriefed their lessons and among the children being taught these inquiry lessons. Vygotsky (1986) posited the importance of the role of dialogue among and between peers and experts as an essential facet of learning. Vygotsky also postulated that cultural artifacts, such as language or other semiotic objects, further contribute to learning development.

Analyzing as a Phase in Conceptual Development

Although Dani was skeptical about using inquiry, she developed a curiosity as she was making sense of the various cultural artifacts she encountered. This may have contributed to motivating her to analyze this method. As she and her team were deciding in which classroom to teach their science lessons, Dani described her team's social interaction in making that decision:

> [After my experience teaching the inquiry math], I was actually more curious than anything to see what was going to happen [when we taught the FOSS lessons . . . In deciding which classroom to teach,] my team and I were just talking, "Well, what class do we use? Do we want to go lower-level? Do we want to go higher level?" And Susanna says, "Well, have you seen my class?" And we said, "No." And she says, "They're really bad, and there's no way we can do our lessons in that class." A lot of those kids are diagnosed with ADHD, ADD and have behavioral issues. And I said, "Wait a minute! What if we try it in that class?" And she says, "Really? You'd want to see a bad class?" And I said, "Yeah, let's try it! Let's see what happens." And that's when we started saying, "Well, think about it. Are they bored or are they bad? Or what's the deal here?" [My partners]

started considering it, and we said, "We want to try this and see what happens."

At this point, Dani was testing whether the inquiry methods could work as successfully with children who had behavioral issues. In a sense, she was using a deductive process to test her pre-concept in this phase of developing conceptual understanding of inquiry. As Dani and her team undertook the FOSS science lesson on the human skeletal system, they had a few glitches at the beginning where some children had tantrums. However, the classroom quickly moved toward full engagement. Dani described this as follows:

> We did the FOSS kit on the human body, with the bones. I think, in [the first] lesson, they had to estimate the number of bones in their body. And I noticed, when [the children] were outside jump roping and making their observations, there were no problems. They were really into it. They were writing everything down that they were supposed to. We didn't have to get on anybody to do anything. Then we go inside. All of a sudden, that's when the chaos broke out. The kids were fighting. There's this little girl throwing a tantrum, and Susanna didn't know how to really control the situation. But she [started] her lesson, and the class started to calm down as the lesson went on. So then the next day, it was Sarah's turn. Sarah was a little strict with them at first saying things like, "You know what? You need to be quiet while I'm talking." They listened to her; there was no fighting then. In her lesson, they had to reconstruct a skeletal system, and they had to put it together. And so the kids are putting bones together, and I noticed that they were just doing it. We didn't have to get on anybody. Dora did the third lesson where we were introducing owl pellets to them. And again, as we went on, it was less disruption, less fighting, less talking. And they were really excited. And then Susanna would tell us that, at the end of every day, [the children] were like, "Are they coming in today? Are we going to do that lesson again?" And they were really, really excited. So toward the end of the lessons, there were no problems whatsoever. The kids were just doing it on their own. They were really interested, and they were really excited. There was a lot of noise, and the teacher comes running in 'cause they're like, "Oooh, man, I found a skull! Oh man, I found this!" And I'm like really excited. So the teacher comes in and, "Is everything okay?" And then she looks around, and she's like, "Oh, my gosh!" She was amazed because the kids were engaged and motivated. And it's funny 'cause she even said at one point like, "Wow! These lessons are really cool!" And so all the third grade teachers end up coming in because there's noise. They're all looking in and are all amazed because these kids aren't fighting.

After this experience, Dani had more curiosity about inquiry methods and needed to know if she could design her own inquiry lesson and if this would produce the same results. Furthermore, she decided to teach this lesson to her internship class, as they were not responsive to their own teacher. She stated, "So, with [designing my own inquiry] lesson, it was kind of putting that to the test. Can I do it?" The following describes her experience.

> And my goal was how to get the class to do something as a whole for Earth Day. It made me really excited because, after that lesson, the kids are coming up to me, and they're like, "Oh, Miss, now I'm recycling at home" and "Oh, Miss, I'm not using my paper bags. I made my mom buy me a lunch box instead" and things like that. And so I saw that they were actually using what I was teaching them and, you know, it took me a really long time to get that lesson together. At the end, it just came together. And I was really, really pleased with the results. In fact, at the end of the year, they were able to still explain to me in detail what happens to the earth if we don't reduce, recycle, and reuse.

Dani realized that she could indeed design her own inquiry lesson, and knew it was successful from the reactions of the children.

Experiencing the Synthetical Moment

As Vygotsky (1978) posited, when a learner synthesizes experiences mediated by the cultural tools and artifacts, a synthetical moment occurs as that learner reflects abstractively and is able to conceptualize meaning as a whole. Dani described the moment when this occurred:

> When I had my little *aha* moment, it was really interesting. I was reading one of the articles you gave us to read about experience and how experience is important. A couple of days before, I had this conversation with my dad. I was telling him about one of my friends, and I said, "Dad, I tell her, and I tell her, and I tell her, and she just doesn't get it." And he says, "Well, Dani, you can tell someone until you're blue in the face, but until they experience it on their own, they're not going to learn it." And I was like, "Yeah, you're right," and just whatever. Then I'm sitting there reading that article, and it was just like, *thunk*! . . . It was like something just like hit me on the head. I'm sitting there, and I literally said, "Oh, my gosh!" I think what amazed me the most is that it was experience that I had had. It was understanding it myself and going through it myself. I went through it. It was a complete 180, like from 0 to 60 in just one little paper. It all just came together. It was in the mix already, and it was just getting there, getting there, getting there. It just finally locked into place, and that's when I opened my eyes completely . . . I realized—*that's* what she's been talking about to us this whole year, you know, inquiry. And *that's* what we've been doing. So, after that, it was kind of like, "What else have I missed?" I was reading these articles, and I was learning it, but, you know, I wasn't really. I was thinking about this yesterday, "What was it like?" 'Cause I learned it, I felt like I did it on my own, and I understood what you were teaching us . . . You didn't say, "Here. You have to learn it this way."

Reading articles assigned in the methods courses had potential for scaffolding learning, as preservice teachers reflected on how these readings related to what they were experiencing in classrooms as student teachers. For Dani, this scaffolded understanding created a significant moment for her. She metaphorically described it:

> When you're watching a 3-D movie, it's kind of blurry without the glasses. You're understanding what's going on, sound and everything; but you have to experience it in order to fully understand it. So when you put those glasses on, that's when you see the picture completely clear, and you completely understand what it is. That's what happened to me. When I was reading that article, I just put those glasses on, and I said, "That's what she's been talking about!" And everything I looked at after that was just completely different to me . . . It just started making so much sense to me . . . Ever since then, my whole views on education and everything had just done a complete 180. And I think my role of what a teacher should be has completely changed from when I first got into the education program. It totally flipped on me. After that, I'm reading these articles, and I start to notice things in the classroom. *Then* I started to think about things, and I started to observe what's going on. After doing my FOSS lesson and being excited about it, I think that's the process of me putting on my glasses. I think that's when I was getting to that point of seeing it a bit differently.

In her description of this transformative moment, she was excited and smiling exuberantly. Dani was liberated. Later she shared with Author Villa a decision she had made at the outset of her final year in her undergraduate studies: She had decided that she did not want to be a teacher and upon graduation would seek another career. However, after this transformation,

she said that teaching was something she was now passionate about and knew was her destiny—something she would do for the rest of her life.

> [This past year] was life-changing. I started one way at the beginning, and it just totally flipped at the end . . . [What I learned from all this is] it *can* be done, and I learned that it doesn't matter your population, because I've seen it done in three different classrooms with three completely different students: Ones who were ridiculously bad; ones who, like in my class, are used to following the rules, and everything is by the book; and this other class that I just didn't know anything about. At the end of every day, I would sit there and reflect, and I said, "It can be done, and it worked." At the end of every single lesson, I sat there, and I said, "It *does* work." And these kids are still talking about it even after the lessons.

Discussion

Preservice teachers' perceptions of what it means to be a teacher are typically informed by traditional pedagogical methods of direct instruction that they experience in their formative years as a pre-college student. As mentioned earlier, Lortie's (1975) sociological study suggested that teachers learn how to teach by observing those teachers who taught them.

This way of knowing what it means to teach is further reinforced during student teaching as prospective teachers engage in and learn the practice of experienced teachers as they interact in the everyday activity of schooling. Too often the everyday activity is interpreted and reified in the following way: Teachers are the experts who deliver knowledge to students who are the consumers of that knowledge rather than intellectual beings capable of constructing their knowledge. Freire (1970) coined this concept *banking* where learners are perceived as empty vessels to be filled by a teacher's knowledge (p. 61).

In this case study, Dani exerted agency to further investigate inquiry as a pedagogical method and reject what she was experiencing as a student teacher under the tutelage of her mentor. She developed understanding of what it means to teach inquiry and allow children to generate their own knowledge.

The cultural tools of the systematic structure of the inquiry materials and use of a lesson study process with its engagement in dialogic interaction and reflection with others contributed to developing this agency. With these materials and process as scaffolding support structures, Dani was able to make the necessary connections to extract and abstract what it means to do inquiry. This process developed over almost two full semesters in a spiral manner, as Vygotsky (1986) posited, where Dani re-visited familiar spaces with new understandings, as her conceptual understanding was materializing and concretizing. As suggested by Fosnot and Perry (2005), learning is complex and non-linear, and is a continual process of negotiating meaning and modifying our interpretation of meaning.

During this process, Dani began to realize the effectiveness of an inquiry method with ELLs in a bilingual class. This comes as no surprise as inquiry methods in an elementary science classroom "set the context for the learners' development of domain-specific language" (Villa, 2010). As a result of Dani's experience with ELLs, she developed epistemic curiosity and systematically selected a classroom of children with behavioral issues to test inquiry. Again these children responded in positive ways.

She then designed an inquiry lesson for the children in her own student teaching classroom to determine (1) if *she* was capable of creating such a design, and (2) if *children* were capable of generating their own knowledge sans the teacher's direction. With favorable outcomes to her analyses, Dani was positioned for engaging in a synthetical moment, the culmination of what Vygotsky posited occurs when a learner realizes how seemingly disparate objects are unified into a single concept rather than being viewed as discrete objects.

To describe her synthetical moment of transformation, Dani used the metaphor of viewing a 3-D movie. In their discursive analysis of metaphors, Lakoff and Johnson (1980) posit the use of metaphors as a mechanism to explain an experience with an express purpose of comprehension. "Metaphors allow us to understand one domain of experience in terms of another" (p. 117).

The abstractive nature of Dani's *aha moment* resulted in her use of a metaphor for explanation. She mentioned wanting to re-read papers given to her in her methods courses, i.e., Dani desired to re-visit familiar spaces with her newfound knowledge, evidence of learning as a spiral process. Through analysis and synthesis, Dani united and separated the concept of what it means to do inquiry. "In genuine concept formation, it is equally important to unite and to separate: Synthesis and analysis presuppose each other as inhalation presupposes exhalation" (Vygotsky, 1986, pp. 135-136).

Conclusion

Many, if not most, educators agree that reflection is an essential element in constructing understanding of a domain-specific discipline, such as mathematics or science. In their 30-year study of learning mathematics using a constructivist perspective, Confrey and Kazak (2006) noted reflection as fundamental for constructing understanding of mathematics. Correspondingly, John Dewey (1916) asserted science knowledge, or construction of understanding of science principles, as "the outcome of methods of observation, reflection, and testing which are deliberately adopted to secure a settled, assured subject matter" (p. 256).

What we have demonstrated here is the case of a prospective teacher who actively and systematically engaged in such a process of observation, reflection, and testing to understand inquiry as a pedagogical method. Kolb (1984) underscores this notion of learning as a process in the following:

> If the education process begins by bringing out the learner's beliefs and theories, examining and testing them, and then integrating the new, more refined ideas into the person's belief systems, the learning process will be facilitated. (p. 28)

This has implications for re-examining how we teach preservice teachers and, more importantly, for their understanding of teaching as facilitation, and learning as a developmental process. This is especially critical for teaching children from diverse backgrounds since inquiry methods have potential to shift power to the learner who will be in control of their learning and knowledge construction.

References

American Association for the Advancement of Science. (1993). *Science for all Americans*. New York: Oxford University Press.

Apple, M. (1979). *Ideology and curriculum*. London, UK: Routledge & K. Paul.

Bonstetter, R. J. (1998). Inquiry: Learning from the past with an eye to the future. *Electronic Journal of Science Education, 3*(1). Retrieved from http://ejse.southwestern.edu/article/viewArticle/7595/5362

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.) (1999). *How people learn: Mind, experience, and school*. Washington, DC: National Academies Press.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher 18*(1), 32-42.

Bruner, J. S. (1960). *The process of education: A landmark in educational theory.* Cambridge,

MA: Harvard University Press.
Bruner, J. S. (1996). *The culture of education*. Cambridge, MA: Harvard University Press.
Cochran-Smith, M. (1991). Learning to teach against the grain. *Harvard Educational Review, 61*(3), 279-310.
Confrey, J., & Kazak, S. (2006). A thirty-year reflection on constructivism in mathematics education in PME. In A. Gutiérrez & P. Boero (Eds.), *Handbook of research on the psychology of mathematics education: Past, present, and future* (pp. 305-345). Boston: Sense Publishers.
Crawford, P. A. (2004). "I follow the blue..." A primary teacher and the impact of packaged curricula. *Early Childhood Education Journal, 32*(3), 205-210.
Darling-Hammond, L., & Bransford, J. (Eds.) (2005). *Preparing teachers for a changing world: What teachers should learn and be able to do*. San Francisco: Jossey-Bass.
Darling-Hammond, L., Hammerness, K., Grossman, P., Rust, F., & Shulman, L. (2005). The design of teacher education programs. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (pp. 390-441). San Francisco: Fossey-Bass.
Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. New York: The Macmillan Company.
Eggen, P. D., & Kauchak, D. P. (2006). *Strategies and models for teachers: Teaching content and thinking skills* (5th Ed.). Boston: Pearson.
Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record, 103*(6), 1013-1055.
Fernandez, C. (2002). Learning from Japanese approaches to professional development: The case of lesson study. *Journal of Teacher Education 53*(5), 393-405.
Flores, M. A. (2006). Being a novice teacher in two different settings: Struggles, continuities, and discontinuities. *Teachers College Record, 108*(10), 2021-2052.
Fosnot, C. T., & Perry, R. S. (2005). Constructivism: A psychological theory of learning (2nd ed.). In C. T. Fosnot (Ed.), *Constructivism: Theory, perspectives, and practice* (pp. 8-38). New York: Teachers College Press.
Freire, P. (1970). *Pedagogy of the oppressed*. New York: Continuum.
Freire, P. 1998). *Pedagogy of freedom: Ethics, democracy, and civic courage*. Lanham, MD: Rowman & Littlefield.
Gee, J. P. (2005). Language in the science classroom: Academic social languages as the heart of school-based literacy. In R. Yerrick & W. M. Roth (Eds.), *Establishing scientific discourse communities: Multiple voices of teaching and learning research* (pp. 19-37). Mahwah, NJ: Lawrence Erlbaum Associates.
Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory*. Chicago: Adeline.
Guba, E. G., & Lincoln, Y. S. (1989). *Fourth generation evaluation*. Newbury Park, CA: Sage.
Hayes, M. T. (2002). Elementary preservice teachers' struggles to define inquiry-based science teaching. *Journal of Science Teacher Education, 13*(2), 147-165.
Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.
Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: The University of Chicago Press.
Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.
Lortie, D. C. (1975). *Schoolteacher: A sociological study*. Chicago: University of Chicago Press.
Loughran, J. J. (2002). Effective reflective practice: In search of meaning in learning about teaching. *Journal of Teacher Education, 53*(1), 33-43.
Merriam, S. B. (1988). *Case study research in education: A qualitative approac*h. San Francisco: Jossey-Bass.
Merriam, S. B. (2001). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass.
Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco: Jossey-Bass.
Monroe, C. R. (2013). Colorizing educational research: African American life and schooling as an exemplar. *Educational Research, 42*(1), 9-19.
Moscovici, H., & Nelson, T. H. (1998). Shifting from activitymania to inquiry. *Science and Children, 35*(4), 14-17.
National Research Council. (1996). *Inquiry and the National Science Education Standards*. Washington, DC: National Academy Press.
National Science Resources Center. (1997). *Science for all children: A guide to improving elementary science in your district*. Washington, DC: National Academies Press.
Newman, W. J., Abell, S. K., Hubbard, P. D., McDonald, J., Otaala, J., & Martini, M. (2004). Dilemmas in teaching inquiry in elementary science methods. *Journal of Science Teacher Education, 15*(4), 257-259.
Oakes, J., & Lipton, M. (2003). *Teaching to change the world*. Boston: McGraw Hill.
Peshkin, A. (2000). The nature of interpretation in qualitative research. *Educational Researcher, 29*(9), 5-9.
Rosenholtz, S. J. (1989). Workplace conditions that affect teacher quality and commitment: Implications for teacher induction programs. *The Elementary School Journal, 89*(4), 420-439.
Seidman, I. (2006). *Interviewing as qualitative research: A guide for researchers in education and the social sciences* (3rd ed.). New York: Teachers College Press.
Siddle Walker, V. (1999). Culture and commitment: Challenges for the future training of education researchers. In E. C. Lagemann & L. S. Shulman (Eds.), *Issues in education research: Problems and possibilities* (pp. 224-244). San Francisco: Jossey-Bass.
Singer, F. M., & Moscovici, H. (2008). Teaching and learning cycles in a constructivist approach to instruction. *Teaching and Teacher Education, 24*(6), 1613-1634.
Sleeter, C. E. (2005). *Un-standardizing curriculum: Multicultural teaching in the standards-based classroom*. New York: Teachers College Press.
Smith, B. (2007). Promoting inquiry-based instruction and collaboration in a teacher preparation program. *Mathematics Teacher, 100*(8), 559-564.
Spradley, J. P. (1980). *Participant observation*. New York: Holt, Rinehart & Winston.
Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Newbury Park, CA: Sage Publications.
Van de Walle, J. A. (2004). *Elementary and middle school mathematics: Teaching developmentally*. Boston: Pearson.
Villa, E. Q. (2010). Interrupting the formation of teacher identities: Using inquiry to shift from teacher-centered to learner-centered. Unpublished dissertation. New Mexico State University.
Vygtosky, L. S. (1978). *Mind in society: The development of higher psychological processes*. (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Cambridge, MA: Harvard University Press.
Vygotsky, L. S. (1986). *Thought and language*. A. Kozulin (Ed. and Trans.). Cambridge, MA: MIT Press.
Wiburg, K. M., & Brown, S. (2007). *Lesson study communities: Increasing achievement with diverse students*. Thousand Oaks, CA: Corwin Press.
Windschitl, M. (2004). Folk theories of "inquiry:" How preservice teachers reproduce the discourse and practices of a theoretical scientific method. *Journal of Research in Science Teaching, 41*(5), 481-512.
Zeichner, K., & Gore, J. (1989). *Teacher socialization*. Retrieved October 15, 2006 from http://ncrtl.msu.edu/http/ipapers/html/pdf/ip897.pdf
Zeichner, K., Grant, C., Gay, G., Gillette, M., Valli, L., & Villegas, A. M. (1998). A research informed vision of good practice in multicultural teacher education: Design principles. *Theory into Practice, 37*(2), 163-171.