Beginning Elementary Teachers' Learning Through the Use of Science Curriculum Materials: A Longitudinal Study

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Abstract

Beginning elementary teachers face many challenges in learning to teach science. They often lack substantial subject matter knowledge, struggle to articulate scientific inquiry in practice, and experience teaching contexts in which science is deemphasized. These factors serve to mediate teachers' interactions with curriculum materials. It is therefore necessary to learn more about the ways in which new elementary teachers use science curriculum materials and how they learn to do so within this crucial stage of the teacher professional continuum. Three beginning elementary teachers were studied longitudinally over their first three years of professional teaching. Results indicate that they engaged in a substantial degree of curriculum design, drawing on a myriad of curricular resources and modifying them in order to craft localized science curricula. These efforts were influenced, in part, by their own orientations toward science teaching practice but also by features of their unique school contexts. These findings have important implications for the field's understanding of teacher learning along the teacher professional continuum and help inform research on teachers and teaching, as well as science teacher education and curriculum development.

Science education reform has historically been a central dimension of educational reform in the United States (DeBoer, 1991) and remains so today with the current emphasis on conceptual understanding and the development of scientific literacy through standards-based inquiry teaching and learning (AAAS, 1993; Bransford, Brown, & Cocking, 1999; NRC, 1996). A consistent theme throughout the history of science education reform has been the preeminence of curriculum as a vector for change. Curriculum materials possibly exert the most direct influence on students' and teachers' day-to-day classroom activity (Brown & Edelson, 2003). As a result, the history of science education reform has also fundamentally been that of science curriculum development.

In recent years, national education reform policy has been characterized by increased accountability and high-stakes testing. While No Child Left Behind has thus far emphasized elementary mathematics and literacy, by 2007, all states must begin administering science assessments to students at least once at the elementary, middle, and secondary levels. However, at the same time that accountability for elementary science teaching is set to increase, science has become a deemphasized component of the elementary curriculum (Goldston, 2005; Marx & Harris, 2006; Spillane, Diamond, Walker, Halverson, & Jita, 2001). Elementary teachers already face numerous other challenges associated with teaching science (Author, 2006c), including limited subject matter knowledge (Anderson & Mitchener, 1994), capacity to engage in standards-based science instruction (Smith & Gess-Newsome, 2004) and a lack of curricular resources necessary to support reform-minded science teaching practice (Appleton & Kindt, 2002). The soon-to-be-realized reprioritization of science in the elementary curriculum will likely necessitate changes in science teaching practices for elementary teachers already struggling to teach reform-minded science.

Elementary teachers have and will continue to require many forms of support to confront these issues. For example, innovative, flexibly-adaptive, standards-based, inquiry-oriented science curriculum materials can serve as a valuable tool in supporting elementary teachers' science teaching. However, in order to better promote teachers' capacity to effectively use curriculum materials, a better understanding of their interactions with such curricular tools is required (Remillard, 2005). It is necessary to learn more about how elementary teachers, especially beginning teachers, use traditional as well as innovative science curriculum materials, the relationship between curriculum materials and teachers' practice and learning, and contextual factors mediating teachers' interaction with science curriculum materials.

The purpose of this research is to characterize three beginning elementary teachers' use of science curriculum materials over the first three years of their professional teaching careers. Two research questions served to guide this study: *how do beginning elementary teachers talk about their use of science curriculum materials, including their mobilization and adaptation of* *curricular resources?* and *how do beginning elementary teachers learn to use science curriculum materials*?

The research presented here adds to a growing body of educational research concerned with teachers' use of curriculum materials (Drake & Sherin, 2006; Remillard, 2005). Thus far, this curriculum research has been focused largely on, for example, elementary teachers' use of mathematics curriculum materials (Collopy, 2003, Lloyd, 1999; Remillard, 1999; Remillard & Bryans, 2004), middle and secondary science teachers' use of science curriculum materials (Enyedy & Goldberg, 2004; Fishman, Marx, Best, & Tal, 2003; Pintó, 2004; Schneider, Krajcik, & Blumenfeld, 2005; Roehrig & Kruse, 2005), and preservice elementary teachers' use of science curriculum materials (Author, 2006a; Authors, in press; Schwarz et al., in review). This research addresses the relative dearth of research on beginning elementary teachers' use of curriculum materials (Valencia, Place, Martin, & Grossman, 2006), particularly those for elementary science.

Theoretical Framework

Extensive curriculum development efforts over the past half-century have done little to bring about sought-after reforms in science and mathematics teaching and learning (Brown & Edelson, 2003; Cohen & Ball, 1999). Many of these curricula were designed to speak through teachers rather than directly to them (Remillard, 2000) and thus succumbed to what Nye and colleagues call the teacher effect (Nye, Konstantopoulos, & Hedges, 2004). Often teachers were not engaged in the development process as contributing participants. Rather, they were viewed by curriculum developers as a delivery mechanism for curriculum content. We subscribe to an alternative perspective in which teachers act as co-developers of curriculum materials (Bolin, 1987; Clandinin & Connelly, 1998; Remillard, 2005).

We define 'curriculum materials' similarly to Shulman (1986) as "the pharmacopia from which the teacher draws those tools of teaching that present or exemplify particular content and remediate or evaluate the adequacy of student accomplishments" (pg. 10). These materials include textbooks, instructional plans, and a wide variety of other representational curricular resources. The relationship between teachers and curriculum materials is one that can be fundamentally characterized by design (Brown, in press; Brown & Edelson, 2003; Remillard, 2005) in which teachers actively engage with the curriculum materials they use, interpreting, critiquing, selecting, adapting, and categorizing (Barab & Luehmann, 2003, Enyedy & Goldberg, 2004; Pintó, 2004; Remillard, 2005; Squire et al., 2003). These related tasks are fundamental aspects of teachers' *pedagogical design capacity* (Brown & Edelson, 2003), or their ability to identify and mobilize requisite resources, including personal resources and external curricular tools, to craft learning environments in light of identified goals or objectives.

Teachers' interactions with curriculum materials are mediated, in part, by their knowledge, beliefs, professional identity, and orientations toward practice (Drake & Sherin, 2006; Drake, Spillane, & Hufferd-Ackles, 2001; Enyedy, Goldberg, & Welsh, 2006; Pintó, 2004; Remillard, 2005; Roehrig & Kruse, 2005). These teacher characteristics or resources (Brown, 2002; Remillard, 2005) influence the ways in which they construct elementary science learning environments (Author, 2004a; Bryan, 2003; Haney, Lumpe, Czerniak, & Egan, 2002; Rosebery & Puttick, 1998). While teachers may leverage curriculum materials towards productive ends in light of these characteristics, they may also do so in ways that are less effective (Pintó, 2004; Schnieder, Krajcik, & Blumenfeld, 2005). Even when teachers believe that they are using curriculum materials as intended, they often enact them differently (Bryan, 2003; Lloyd, 1999; Remillard & Bryans, 2004). Elementary teachers may rely on a wide variety of engaging but conceptually disconnected 'activities that work' (Appleton, 2003) in science. They may deprioritize the development of curricular knowledge and pedagogical design capacity within the broader scope of their developmental trajectories (Anderson, Smith, & Peasley, 2000) and they may not view curriculum design as a part of their professional roles as teachers (Bullough, Knowles, & Crow, 1992; Haney & McArthur, 2002; Southerland & Gess-Newsome, 1999).

Beginning teachers often find themselves with insufficient curricular resources (Kauffman, Johnson, Kardos, Liu, & Peske, 2002). This is particularly problematic given the degree to which beginning teachers rely on curriculum materials to support their teaching practice (Grossman & Thompson, 2004; Valencia et al., 2006). In order to help support beginning elementary teachers' development of science teaching expertise, we have developed a technology-mediated teacher learning environment called the Curriculum Access System for Elementary Science (CASES) (Author, 2004b). CASES provides inquiry-oriented science curriculum materials that are intended to be educative for these new elementary teachers (Author, 2005b; Ball & Cohen, 1996) and include additional supports, including an online discussion space and reflective journaling tool. CASES is grounded in design principles that are instantiated in the curriculum materials themselves and a model of scientific inquiry derived from that promoted by the National Research Council (2000). CASES curriculum materials provide rationales for pedagogical approaches and support teachers in adapting them in ways that reflect their unique teaching contexts. Such features help support teachers at this crucial stage of the teacher professional continuum (Feiman-Nemser, 2001) by making innovative curriculum materials more *flexibly adaptive* (Barab & Luehmann, 2003; Fishman & Krajcik, 2003; Schwartz, Lin, Brophy, & Bransford, 1999). As a result, such curriculum materials are inherently more accessible to teachers whose unique classroom contexts necessitate curriculum modification and thus support teachers' learning in context (Putnam & Borko, 2000).

As science curriculum developers and elementary teacher educators, we have worked to better understand how science curriculum materials can support preservice and new elementary teachers' science teaching practice and learning. We have learned much about preservice elementary teacher's use of science curriculum materials, including CASES materials (e.g., Author, 2006a; Authors, in press), and have begun to report findings from our work with beginning (i.e., early career) elementary teachers (Author, 2006b). In this study, we sought to learn more about how beginning elementary teachers use, and learn from their use of, science curriculum materials. This research helps further illuminate the field's understanding of elementary teachers' unique needs at this stage of the teacher professional continuum.

Methods

The research presented here involved three beginning elementary teachers studied longitudinally over the first three years of their professional teaching careers. These results are part of a larger, ongoing longitudinal study of seven beginning elementary teachers begun in 2002 and undertaken to better understand beginning elementary teachers' knowledge and science teaching practice, particularly inquiry-oriented teaching, their use of science curriculum materials, and their professional learning during this critical phase along the teacher professional continuum. The three teachers discussed here were chosen because of their similar positions along the continuum of professional teaching and their unique school and curriculum contexts.

The teachers in the longitudinal study, including those for whom results are presented in this paper, were voluntary participants.

Research Design

The purpose of this study is to construct a richly-descriptive understanding of these three beginning elementary teachers' use of science curriculum materials and learning over time (Donmoyer, 2001) by drawing upon both qualitative and quantitative measures of their own professional experiences. In designing this study, we conceptualized the qualitative research process as one characterized by argumentation (Eisenhart & Howe, 1992) that is inherently embedded in the pragmatism of social science research (Strauss & Corbin, 1998) and based on foundational principles of qualitative research (AERA, 2006).

Participants and Overview

The three teachers who participated in this study each graduated from an undergraduate elementary teacher education program at a large university in the United States. The four-term, cohort-based program is aligned with foundational tenets of teacher education reform (e.g., INTASC, 1992; NCATE, 1987) and content area standards (e.g., AAAS, 1993; NCSS, 1994; NCTM, 1991; NRC, 1996). See Author (2006a) for a more detailed description of the program and elementary science teaching methods course. The summer after completing the teacher education program, each teacher obtained an elementary teaching position for the following year and was invited by the second author to participate in a multi-year longitudinal study. These teachers were contacted because, based on CASES team members' relationships with them as students in science methods courses, they seemed likely to be reflective about their science teaching and interested in participating in a project that would provide them with a form of professional development in science teaching. The teachers were given the option of participating in the study to varying degrees; they each chose the most substantial level of participation. This involved teaching at least one CASES unit each year, maintaining a variety of records of science teaching practice, and participating in three annual interviews as described in the data collection section that follows. To better enable their use of CASES and communication with the research group members, each teacher was provided a notebook computer early in the first year but did not receive any additional compensation over the course of the study. In the results that follow, pseudonyms have been used for the teachers.

Catie. Catie began teaching in the fall of 2002 and, throughout this study, taught in private Catholic elementary schools. During her first year, she taught sixth grade in a relatively small school in an affluent suburb of a major metropolitan area nearby the university community. She noted her students were predominantly Caucasian, class sizes were relatively small, and she taught science at least four days a week. She described her school as “more traditional than reformed” and, as a result, “the subjects that we teach… we try and be flexible and creative but a lot of it is basics. They really want basic stuff" (Catie, Int. 1.1, 114-118)[1]. While students in every grade level at her school were assessed in science annually, she had a relative degree of freedom in choosing science content and designing instruction. During her first year, Catie had a full set of science textbooks and associated investigative materials from a major publisher.

Between her first and second years, Catie accepted a new second-grade position in a much larger Catholic elementary school. While demographically and culturally similar, the nature of her professional role shifted dramatically. Her class sizes were larger and she began teaching roughly twice as many subjects, leaving little more than a few half-hour blocks each week for science instruction. She noted that when she was hired, the principal at her new school told her that their science curriculum was very textbook-driven. In addition to receiving new science curriculum materials during her second year of teaching because of her move, she was provided another new set before her third year. Similar to those she used previously in her sixth grade teaching position, the science curriculum materials she used in years two and three were text-based materials from a major textbook publisher. She also said that a disproportionate percentage of instructional time went to mathematics and reading.

Catie remained at this new school throughout the remainder of the study and is still actively involved in this research.

Lisa. Lisa began teaching in the fall of 2002 and participated in our study for the first three years of her teaching, during which time she taught fourth grade at a small, socioeconomically heterogeneous and predominantly Caucasian public elementary school. She described her school as one in transition. Her principal, who had only been at the school a few years before Lisa arrived, was committed to innovative reform and had attempted to reconstruct the professional culture of the school. She described the faculty as split between veteran teachers with many years of experience and beginning teachers.

Over these three years, Lisa taught science roughly four times a week. In her first and third year she switched classes with another fourth grade teacher and had the opportunity to teach science twice per day. During her first two years, Lisa used a set of commercially-available science curriculum materials provided by her school. Instead of a single textbook, these materials were organized around separate topical texts. There were also comprehensive kit-based investigative materials associated with these texts but no lesson plans. Between her second and third year, Lisa's school purchased new science curriculum materials for fourth grade.

At the end of the third year, Lisa remained in her fourth grade teaching position but dropped out of our study.

Whitney. Whitney began teaching in the fall of 2002 and participated in our study for three years, her first three years of teaching. Throughout this time, Whitney taught fourth grade in a grade 4-8 public school on the West Coast that drew a very high population of military personnel and had a highly transient student and teacher population. Whitney assumed a number of leadership positions early on that would most often be reserved for more experienced teachers, such as mentoring a first-year teacher and becoming the grade-level chair at her school.

Whitney taught a wide variety of subjects. However, she taught the same six-week electricity and magnets unit six times each year. Whitney taught science, on average, two to three times a week for an hour and used kit-based science curriculum materials from a major curriculum developer. Whitney's school has relatively few resources and, as a result, many of her curriculum kits were consistently missing required resources.

Whitney moved after her third year of teaching and was unable to find a K-12 teaching position. As a result, she dropped out of our study.

Data collection

Three forms of data were collected in this study. First, semi-structured, audio-taped interviews were carried out with the teachers three times annually for three years. These interviews were designed to be approximately 45-60 minutes in length, though they often went substantially longer, and occurred once in the fall, winter, and end of the academic year. Each was administered over the phone by CASES research group members, not the authors. These interview protocols were designed to provide the teachers an opportunity to describe their school settings, articulate their general views on science teaching and use of science curriculum materials, and discuss their learning and development. During each of the interviews, the teachers were specifically asked to describe planning for and enactment of science instruction, critique and suggest modifications for sample science lesson plans, and reflect on hypothetical classroom scenarios.

Two additional data sources, reflective journals and daily logs, were embedded features of CASES that the teachers accessed and used online. The reflective journaling tool is open-ended but provides scaffolding to promote productive reflection on practice. The teachers were asked to complete at least one journal entry each week. They were also asked to regularly complete CASES daily logs for each CASES lesson they taught and were encouraged to complete them for most of their science instructional sequences. The teachers varied considerably in how consistently they completed journal and daily log entries. Finally, the CASES website generated usage statistics that illustrated how often teachers visited the site, what pages and resources were accessed, and for how long.

Data analysis

Each of the audio-taped interviews was transcribed, all CASES journal entries and daily log files were transformed into standard text documents, and CASES usage statistics were imported into statistical analysis software. We employed thematic analysis to analyze the qualitative data. Because of their substantial depth and richness, the formal interviews were foundational data sources that served as beginning points for analyses. The remaining data sources primarily served to further illuminate thematic trends we observed in the interviews, particularly as related to curriculum materials enactment and, in the absence of observational data, teachers' narrative and categorical descriptions of their science instruction.

Analysis involved an iterative process of data coding, reduction, displaying, and verification of data (Miles & Huberman, 1994). The first author began data analysis by developing a coding scheme that was informed by current research on teachers and curriculum materials (Remillard, 2005) and dominant criteria relevant to inquiry-oriented science teaching as instantiated in the CASES curriculum materials and our own teaching and ongoing research efforts (e.g., Author, 2006a). After developing and testing numerous related coding keys, we finalized an initial coding key that guided comprehensive analysis. As analysis progressed, additional codes were added to account for emergent themes related to these dominant categories. The final coding key is shown in Table 1.

<INSERT TABLE 1>

Coded examples for each of these codes are presented in the Appendix. As definitive patterns emerged from thematic coding, the data were reduced to isolate and illustrate key factors. This process continued until dominant themes had been refined and substantiated.

To enhance the validity of conclusions (Johnson, 1997; Krefting, 1991), we triangulated data between the interviews, reflective journals, and daily logs. The purpose of this was to challenge tentative claims generated from the interview data by searching for supporting and contrasting data and, through disparate data, further elaborate the phenomena under study. Second, we sought to achieve a high level of inter-rater reliability. The first author coded 100% of the data. A second independent rater coded a subset of the data that was selected at random. The average inter-rater reliability was 90%. After discussion, 100% agreement was reached.

Results

The findings presented here illustrate how these three beginning elementary teachers engaged in substantial curriculum design, mobilizing a wide variety of curricular resources for science teaching and constructing curriculum materials that were uniquely suited to their own teaching contexts. In answering our first research question, *how do new elementary teachers talk about their use of science curriculum materials*, we found that they relied on science curriculum materials to structure their science teaching, though each did so in unique contexts and with different sets of curricular tools. For each teacher, curricular resources they were provided by their schools were found to be insufficient in appropriating the vision of science teaching they articulated for themselves and, as a result, they mobilized a variety of additional curricular resources for science. How they engaged in curriculum design for science teaching, however, was largely a function of the three teachers' unique orientations toward science teaching and evolved over time as these orientations, as well as other factors, also changed. In addressing our second research question, *how do new elementary teachers learn to use science curriculum materials?*, we found that the teachers' learning to use science curriculum materials developed over time but was also influenced by the particulars of their teaching contexts. This was especially the case in regard to changing curriculum materials and changing curricular objectives, as well as their opportunities for iterative cycles of planning, enactment, and reflection. We elaborate first on the teachers' of science curriculum materials.

Teachers' Use of Science Curriculum Materials

Each of the three teachers studied here prioritized authentic, active, standards-based science teaching and learning. This finding was not unexpected since each had taken the science teaching methods course that emphasized these principles of effective science teaching. They each came to quickly view the mobilization and adaptation of external curricular resources as a natural and essential dimension of effective science teaching. As Catie noted at the end of her first year:

> I can't say if there was one activity or experiment that I did this year that I wouldn't have some sort of modification to it. Most, if not all had at least little like blurb in there like, try this next time and see how this works. Not a guarantee that it's going to make it better but, like this didn't work so good, so try something different next time. (Catie, Int. 1.3, 684-688)

In engaging in such curriculum design, the teachers made principled decisions about how, what, and why to modify in preparation for and in response to enactment and sought to achieve a balance between the curriculum materials and their own views of inquiry-oriented science teaching and learning. The additional materials that they drew upon were diverse and targeted at those parts of their science curriculum materials that they perceived to be lacking.

However, the teachers found themselves navigating different paths through curriculum design for inquiry-oriented science teaching. Catie and Lisa both utilized text-based science curriculum materials provided by their schools but were critical of these resources, especially during their first years. Over the course of the study, they mobilized investigation-oriented science curriculum materials and integrated them into the text-based curriculum materials they already had. In contrast, Whitney found herself utilizing more text resources to supplement her investigation-oriented science kits. According to their daily logs across all three years, Catie and Lisa used text in 49% and 34% of their respective science lessons, whereas Whitney reported doing so only 9% of the time because, as she noted, “since I don't have textbooks, everything is hands-on, simple as that” (Whitney, Int. 1.3, 59-60). We next describe the unique ways in which each teacher mobilized and adapted science curriculum materials over time.

Lisa. Lisa began her first year teaching fourth-grade in small public elementary school. In addition to having the science curriculum materials described previously, she also reported having a clear and explicit set of district-based, grade-specific learning goals for science as part of her science curriculum. For Lisa, the emphasis on specific goals for student learning became an important consideration in her reflections on science teaching and her professional growth. For example, she wrote in year one,

> There are so many aspects of a science concept that when teaching science you need to make sure you are narrowed in on what you want to teach. You cannot be too broad and try to fit everything in and believe that just by mentioning it you have covered it. (Lisa, Year 1 Journal, 16-20)[2]

Throughout the study, Lisa often reported tailoring her science instruction to particular district-derived goals that had a significant impact on her science teaching.

Not surprisingly, this attunement to learning goals served as an important influence on Lisa's use of science curriculum materials. Lisa did not have a textbook but rather utilized science curriculum materials that included separate books for topics and associated materials to support student investigations. In discussing her school-provided science curriculum materials, she noted that "a lot of the kits are incomplete" and, because these materials did not include lesson plans for the teacher, she didn't "know what the stuff in there is for" (Lisa, Int. 1.1, 89-106). She felt that they were not particularly well-suited to supporting her to address these goals and noted that "I haven't been using them that much" (Int 1.1, 88).

Lisa engaged in what she described a highly design-oriented approach to instructional planning for science during her first year. When she was asked, for example, where she got most of the science curriculum materials she actually used, Lisa said "I've had to make up a lot of my stuff on Saturday" (Lisa, Int. 1.1, 134-136). She noted that this involved drawing from a variety of what she considered to be high-quality science curriculum materials, particularly CASES materials, saying, "I really like [CASES] because I…just don't want to go and pull things off the web…when you have this website that's reliable because I know it's from [the university]…I understand it because that's how I was taught how to do science units so it makes a lot of sense to me" (Lisa, Int. 1.1, 150-154). Lisa's emphasis on curricular objectives continued in her talk about using these materials. For example, she said about her use of CASES:

> I always have to think when I use CASES, because it's not specifically geared towards my curriculum …, does this fit or how can I just change it a little bit so that I can still use the lesson or use a part of the idea to make it fit more. (Lisa, Int. 2.2, 209-217)

In this way, her mobilization of curricular resources for science was heavily influenced by her attunement to grade-specific learning goals.

Lisa reported using her school-provided science curriculum materials in a very limited way early in her first year. Instead, the series of science lessons she developed became her science curriculum. These curricular resources were especially important since they were explicitly linked to the curriculum standards she was supposed to teach. Throughout her first year, she spent a good deal of time and energy organizing the resources she had pulled together, noting that "for every subject that I teach, I had binder so throughout the year if I find something in a book about something, I just throw it in that binder" (Int. 2.1, 164-166). Over time, these composite, teacher-created science curriculum materials became important resources for Lisa. For example, Lisa discussed a magnets unit that she developed and enacted. In her second year, she was able to use these materials to again structure her magnets unit.

> I went and got my binder that's full of my magnet stuff that I taught last year and…I put together so all the stuff that I used last. I probably read through the

> unit that I did last year, and I looked to see what my line item for our report card was, and it just said the student can describe the properties of magnets …so then I went to my curriculum to look to see the objectives for magnets and from there, they were the same as last year so I just kind of read through the unit again and decided last year that I didn't have a driving unit question. (Lisa, Int. 2.1, 117-136)

In the first two years of the study, Lisa reported developing multiple science units such as the magnets unit described here, drawing on not only the science curriculum materials she had at her school, but more so additional material that she pulled from external sources, including CASES. Her efforts doing so were most prominently influenced by her school district's fourth-grade curricular objectives, which provided a concrete framework around which she oriented her curriculum design tasks. For Lisa, this trend remained consistent over the three years she participated in the study.

Catie. Like Lisa, Catie engaged in substantial curriculum design for science during her first year teaching sixth-grade at a private Catholic school. However, unlike Lisa, she emphasized her ideas about inquiry-oriented science teaching and expectations for her students as critical mediating factors in her mobilization and adaptation of science curriculum materials. Early on, she prioritized an emphasis on meaningful and engaging science learning experiences for students. These often took the form of inquiry-oriented investigations. However, over time, she began to orient herself away from an emphasis on these types investigations alone, working instead to provide a much more diverse set of types of learning opportunities for her students. This trend influenced her use of science curriculum materials over the course of the study.

Catie was somewhat critical of the science textbooks she had at her school during her first year, saying that she wasn't "a big fan of them" (Catie, Int. 1.1, 148-150). Only a few months into that school year, like Lisa, Catie admitted that she had already quit using them. Also like Lisa, Catie began developing individual science lessons and comprehensive science units using a wide variety of external curricular resources. She stated at the end of her first year that "I can't say that I've really been using lessons from any other place. I'm just kind of like creating what I think needs to be taught and pulling from different sources and making up my own lessons" (Catie, Int. 1.3, 320-323). Many of Catie's units, however, were much more project-based rather than lab- and experiment-based as Lisa described. For example, during her first year, she developed a science unit centered on water quality in her school's community.

> I started a unit like on the water cycles and water quality. I thought it might be kind of interesting since we're right there on [the lake] and I can take my kids on a five minute walk down there and test the water. I developed a unit around dealing with just the water cycle in general and the quality of [the lake's] water,

> which has been a big thing in current events. The kids have been really interested in that, probably because it's a place where they go swimming and boating in the summertime and a lot of them live right on the water or close to it. (Catie, Int. 1.1, 194-201)

When asked how she had developed this unit, she described an extensive and multi-faceted process of curriculum design.

> [It] wasn't anything that was given to me, I just kind of was going about it on my own without any resources, finding them as I went along. I found a couple lessons on my precipitation, condensation, evaporation on the web. And then I just supplemented things. I found a video in our school library on water cycle and polluting water. Then I had them go and do a little research looking into newspapers and things for information on pollution how water becomes polluted and more specifically I had them also do another assignment on just trying to find articles on how [the lake] itself was being polluted and what people were doing about it, what the law was behind pollution. (Int. 1.1, 203-213)

This approach to science teaching was a consistent theme in Catie's first year. It is an impressive feat for a first year teacher and one that served to motivate Catie in her science teaching. She reflected at the end of her first year, noting, "I did like going on my own and trying to figure out what I was going to teach and trying to make it more centered towards them and giving them meaning in their own lives instead of just stuff coming out of a textbook" (Catie, Int. 1.1, 662-669).

Over time, Catie began to move away from this project-based approach to science teaching and focus more on expectations for her students and providing necessary structure in her use of science curriculum materials. For example, during her second year, after she had begun teaching second grade in a new school, she modified a CASES lesson modeling bird beaks to teach about natural selection to use in her classroom. She had been working on a strategy to more explicitly support her students' understanding of specific elements of scientific inquiry and "trying to get kids more involved in the scientific process like predicting and experimenting, analyzing and all that" (Int. 2.1, 190-191). She saw this as an opportunity to incorporate her new strategy into the CASES lesson. She reflected,

> I took the worksheets and I did new ones… I broke everything down. The first thing that we did was look at the bird beaks. I took 12 pictures off of one of the Internet sites that was mentioned in the lesson and showed each of those beaks and we predicted what we thought each bird beak would eat. And then they went through and did the experiment, like is outlined in the lesson, and then at the end we gathered all of our information into a chart and then we made a final decision

> of what we thought each bird in those pictures would have eaten. I mean it's not very different. But when I made the new worksheets up, there were individualized columns for each step. (Int. 2.1, 201-209)

Catie's primary justification for developing this approach to teaching science as inquiry and changes she made to the CASES lesson were based on her own assessment of her students' unique needs.

> …for my second graders especially, and I think it's true for all young kids, structure and consistency is something that they need so much, they need that structure still, and so for this hands on [activity], giving them that structure by going through each step and having something to do at each step really made it much smoother. (Int. 2.1, 212-217)

In much of her talk about her use of curriculum materials in her second and third years, Catie focused on adapting science lessons in ways that provide higher degrees of structure for her students. This was particularly the case for collecting and organizing data and evidence, whether from investigations or other types of student activities, such as research and teacher demonstrations.

Providing this structure for her students became an important component of motivating and helping them understand the meaning of science learning opportunities that she cited as lacking when the use textbooks was overemphasized. By the third year of the study, Catie had not only continued emphasizing this structure but also providing students a variety of types of learning opportunities, not just more traditionally-defined investigations.

> I've kind of branched away my thinking, before I was thinking I have to be doing so many more experiments with them. Other kinds of activities, like a computer webquest, assembling a planet book, I think are good activities for the kids to gain knowledge, just as much as experiments are. So I think that those are also effective ways of teaching science…just having a variety instead of like being read the text, do an experiment, read the text, do an experiment,…I think that gets dry too even though they're doing something hands on. (Int. 3.1, 734-746)

The interaction between Catie's ideas about science teaching and her use of curriculum materials evolved dramatically over the course of the study.

Catie identified strongly as a science teacher. Early on, this was manifested in a highly investigation-oriented perspective on science teaching. As a result, in her first year she engaged in a substantial amount of curriculum design for science and developed highly open-ended, project-based science units.

As time went on, however, Catie increasingly relied on the science curriculum materials she had at her school while not overrelying on textbooks. When she did mobilize and adapt external curricular resources, she most often did so with the express purpose of providing more structure for her students. While Catie prioritized teaching science as inquiry and retained a science-oriented image of herself as a teacher, she shifted away from an emphasis on investigations to a wider variety of activities that she could use to support students' science learning.

Whitney. Like Catie and Lisa, Whitney also drew upon a variety of curricular resources to teach science in her fourth grade classroom over the course of the study. Unlike the other two teachers, however, Whitney was provided kit-based science curriculum materials by her school and used these as her central curricular resource for science. She said,

> We don't have science textbooks, we have really, really old ones, that, there's one set for the whole fourth grade that somebody just happened to keep instead of get rid of, when they got rid of those science books. So we don't really use those, we use the kits mostly (Whitney, Int. 1.1, 305-307)

In general, Whitney reported that she was satisfied with using her science kits, though also noted that they were often missing pieces and that there was little funding at her school to keep them fully stocked. However, she said that they were generally consistent with her approach to teaching science. Whitney used these same science kits throughout the study.

Like Catie and Lisa, Whitney also drew on external curricular resources to supplement her science kits. Similar to Lisa, she cited learning goals as an important reason for doing so. However, unlike Lisa, Whitney did not engage in wide scale curriculum development but rather identified particular state standards she was expected to teach that were not, she felt, addressed in her existing curriculum materials. She therefore drew on other existing lesson plans, particularly from CASES and online sources. For example, she discussed the valuable role the CASES curriculum materials had served in her attempts to engage in standards-based science instruction.

> I really like having [CASES] because…there's things I need to teach in the standards that have nothing to do with any of the stuff [in the kits] that I have. They have nothing to do with the […] kit at all. I have to, with like having to teach the concept of like static electricity, there's nothing in the kits about it, but [CASES has] a lesson on it so I can take some of that stuff and use it to teach them what they're supposed to know. (Whitney, Int. 2.3, 404-413)

Throughout the study, Whitney maintained a highly student-centered perspective and science teaching, seeking to emphasize the role students can play in driving instruction. She articulated this in her first interview, saying,

> I really think that you get the kids engaged in what they're learning about, I think it's really [important to] make it interesting for them, and also make it so that they

> retain the information. I think if you use some hands-on stuff and also discussions and things like that, where the kids can come up with answers, and the kids are guiding it, so that, that way, you know that they're understanding what's going on. And also, getting them to really probe into what you're doing. (Int. 1.1, 291-300)

In her descriptions of her science teaching, this often manifested itself in an extensive use of questioning to scaffold her students in-class activities and the use of instructional strategies that illustrated an attunement to ongoing informal assessment.

Whitney's student-centered orientation to science teaching was often apparent in her talk about her use of science curriculum materials. In her first year, for example, Whitney used the CASES electricity and magnets unit for the first time to supplement a unit from her science kit on the same topic. While each addressed similar scientific concepts, Whitney noted that they did so using different sequencing. When incorporating new science curriculum materials, Whitney often had to negotiate conceptual ties that had already established with those instantiated in new curriculum materials since, unlike Catie and Lisa, she was supplementing her existing curriculum materials rather than redeveloping them. She said,

> W: The CASES unit was designed backwards of what I did in the other units. Like my other units started with magnets and CASES ended with magnets. So that

> was a little bit different because I was like, how are you going to do electromagnets without magnets, right? But, it ended up making sense.
>
> I: So which order did you do it for this last unit?
>
> W: I did the magnets first. I liked the magnet first because it was something that we could talk about describing magnets and the properties and it was something that once I showed them what I had with the black circular magnet, you know we described what it looked like and then it was something that they kind of knew about. Electricity was a little bit harder concept for them. So it was nice to be able to, especially with the kids being able to start out with something that they kind of understood a little bit or had seen before. (Whitney, Int. 1.3, 303-325)

In the end, while she incorporated the CASES lessons into her existing electricity and magnets unit, consistent with her student-centered orientation to science teaching, she retained the sequencing that she felt would make the material most accessible to her students in light of their previous learning experiences.

Despite Whitney's reported satisfaction with her existing science curriculum materials and apparent success with supplementing them, her curriculum context differed significantly from Catie and Lisa's. While she too noted that an overly text-oriented approach to science teaching was not the type of teaching practice she sought to engage in, over time she acknowledged with increasing frequency that she would like to have a textbook to use in conjunction with her science kits. Even by the end of her first year, she was beginning to look for content resources, writing,

> I also find it difficult at times to have only hands-on materials for science. I feel that textbooks with some information would help the students as well, as a reference as well as a starting point or a way to fill in the gaps of things we cannot experiment with in the classroom. (Whitney, Year 1 Journal, 11-15)

This feeling was exacerbated the following year when an experience enacting her electricity and magnets unit caused her to further revisit her approach to using text as a part of science teaching.

> If we were reading something, [the students would] say 'this isn't science, when are we doing science? Science is when we do stuff' … but they would just play around with the stuff and if I asked them about it the next day they didn't remember, so I was like I really need to incorporate more [subject matter text] right away. So that's when I was really like I need to find more ways to present the material…use the book more often instead of just like once or twice or try and read it all at one time (Whitney, Int. 2.3, 1154-1180)

Having essentially no texts or other sources of subject-matter text became a notable challenge in her active, investigation-oriented classroom. She had stated early in her first year that one of her goals as an elementary science teacher was to not only make science enjoyable and engaging for her students, but also promote authentic learning that was meaningful and applicable to them. This particular experience seemed to be pivotal in Whitney's development in that it suggested to her that this goal was not being met. As a result, unlike Catie and Lisa, she began to place increased emphasis on textbook use and its role enabling content-rich learning experiences.

Whitney's student-driven approach to science teaching, which was evident throughout the course of the study, was an important factor in her use of science curriculum materials. In many ways it was uniquely suited to her use of the kit-based science curriculum materials she had been provided by her school, through which she described engaging in science teaching that involved a high degree of student and teacher questioning, collaboration, and sense-making. However, she also came to appreciate the limitations of her curricular resources, increasingly working to integrate more content-oriented text resources into her teaching for the express purpose of supporting students' science learning.

Summary. For the three teachers, negotiating the text-oriented and investigation-oriented tension they each articulated involved using their science curriculum materials in a way that enabled them to engage in effective science teaching. They experienced a wide variety of science curriculum materials in their individual school settings and used them as tools in ways that reflected their own orientations toward science teaching. In each case, they did not perceive the materials they were provided by their schools to be sufficient on their own. For Catie and Lisa, this meant deemphasizing the role of the textbook in their classrooms and, instead, providing students more investigative experiences and benchmark experiences with other content-specific text resources. For Whitney, this meant steadily increasing the role of informational text. Through the mobilization of additional curriculum resources, they sought to achieve a balance between text-oriented and investigation-oriented materials and experiences that reflected their views of inquiry-oriented science teaching and learning. In this way, the process of curriculum mobilization became a function of their own ideas about effective science teaching and the science curriculum materials they initially had.

Teacher Learning Through the Use of Science Curriculum Materials

In addition to characterizing these three beginning elementary teachers' use of science curriculum materials, we sought to also investigate how such tasks facilitated their professional learning through our second research question: *how do new elementary teachers learn to use science curriculum materials?* While their learning to use science curriculum materials evolved over time, the teachers' unique teaching contexts, and their use of curriculum materials within these contexts, proved an equally important influence on their opportunities for ongoing learning and professional growth. Features of these teachers' school settings, including the science curriculum materials they had to use and the relative stability of their local curriculum standards, had a profound influence on their opportunities to engage in iterative cycles of curriculum design, enactment or construction, and subsequent reflection.

Before we turn to a discussion of the teachers' learning, we first describe salient characteristics of the teachers' curricular contexts. Many characteristics of these teachers' work contexts mirror what has been more recently reported in the research regarding elementary education and, in particular, elementary science. The high-stakes, accountability-oriented nature of current elementary education reform efforts had a significant influence on their local school contexts, even in the private Catholic schools in which Catie taught. Instead of the explicit emphasis on mathematics and literacy, science as a subject was afforded a subjugated status within the teachers' local curricula. For example, as Whitney noted, "our school doesn't really push for a lot of science because it's not on any kind of test, so it's kind of a fun thing to learn, but it's not something that they consider vital" (Whitney, Int. 1.1, 816). As a result, there was less instructional time devoted to science. Whitney wrote in her journal in year two,

> Right now we are preparing for the state standardized testing. Science is really getting pushed to the side as we are pushed and reminded to make sure that all of the math and language arts standards are well known by our students. (Whitney, Year 2 Journal, 5-8)

Similarly, when it came to curriculum materials and associated resources, science teaching was rarely a top priority. The teachers had relatively minimal resources for science and sometimes struggled to pull together materials needed to teach lessons from science curriculum materials they drew upon from outside of their school contexts.

Within this broader elementary science education environment, the three teachers in this study faced challenges specifically related to their use of science curriculum materials. For example, Catie had the opportunity in her first year to take full advantage of her enthusiasm for science and self-identification as an elementary science teacher. In this setting, the district-mandated science curriculum stressed fundamental concepts but was relatively flexible and not overly-prescriptive.

> …it's not like in public schools where you could only teach something if it's in the standards. I can teach anything I want pretty much in science, which is good. (Catie, Int. 1.1, 170-174)

This allowed her to draw upon a myriad of science curriculum materials to create highly project-based, inquiry-oriented science units as discussed previously. She reflected on her first experience developing and enacting her water-quality unit, saying,

> …after teaching this unit,...I wish I would have done them a different way. I needed to become more knowledgeable. I wasn't exactly clear on all these

> definitions when I first started teaching it so I was kind of learning along with them. Whereas in five years I would hope that that information would be so almost intuitive that I would just be able to sit and have a conversation and have all this knowledge to be able to help them understand …Because I don't have the background knowledge and I haven't obviously taught this too many times I didn't know where I was going with it. If I plan on doing units where I'm developing them myself instead of using a textbook and stuff I would hope that in five years I would have them revamped and have a better idea of where it's going and how much time it'll take. (Catie, Int. 1.1, 586-615)

Catie acknowledged that the curriculum design processes she had engaged in had supported her subject-matter learning and how, through iterative cycles of curriculum design for science teaching, her subject matter knowledge and curricular knowledge, a crucial dimension of pedagogical content knowledge, would continue to develop.

However, Catie received new school-provided science curriculum materials each year during the study. After moving to a new school and switching to a second grade teaching position after her first year, she also found herself teaching under what she described as a more highly-structured science curriculum, within a school culture where students had little experience with inquiry-oriented science teaching and learning, and where science was deemphasized in the elementary curriculum. She felt that much of the freedom she had experienced in her previous teaching position was absent from her new one and that she was always “trying to keep up with the other teachers” (Catie, Int. 2.2, 120-122). She also had to reorient the expectations she previously held for her sixth-grade students to the second-grade students in her new teaching position. Catie struggled during her second and third year to negotiate her changing science curriculum materials, pressure she felt to engage in science teaching that was consistent with her colleagues’, as well as expectations she had for her students. At the end of her third year she reflected on her developing capacity to engage in curriculum design for science teaching, saying,

> I’m hoping that my science classroom would look more organized…I feel like I really plan for stuff but then it doesn’t go the way I want it to be and then everything else is thrown off. I feel like hopefully in a couple of years, maybe even at the end of the next year, I’ll feel better about it. I’ll know what to expect from the kids. I’ll know what experiments are good and which ones aren’t and…have kind of a better game plan. I guess is my overall goal is to get it so it’s easier to plan…and get the materials together. (Catie, Int. 3.3, 970-989)

Even though Catie learned to use a wide variety of science curriculum materials to develop project-based science units during her first year, the demands of her new school and curricular context did not afford her the opportunity to build on previous curriculum design experiences.

Instead, her curricular goals for science and science curriculum materials, as well as her own ideas about science teaching practice, were in a constant state of flux. As a result, by the end of the study, Catie was still learning to effectively mobilize and use science curriculum materials in order to engage in science teaching practice that was consistent with her ideas about effective elementary science teaching.

Lisa also struggled to use science curriculum materials to engage in the type of science teaching she envisioned. As discussed previously, Lisa prioritized curricular goals and objectives in her mobilization and adaptation of science curriculum materials. However, she suggested that the way her curriculum standards were written encouraged traditional approaches to science teaching. She noted that she often found it challenging to leverage her district's science curriculum standards to teach in ways that were consistent with her conception of effective science teaching.

> For my curriculum and on my report card line item it says, 'Can name and identify the parts and functions of the digestive system'…that's all I had to teach…basically memorization. It's kind of difficult to teach so that's why I did a lot of the stations and hands-on kind of stuff. I tried to connect it a little bit, but it was kind of thrown in there. (Lisa, Int. 1.3, 142-153)

Lisa consistently worked to find ways to address curriculum standards through inquiry-oriented teaching and found her existing science curriculum materials insufficient to do so. While she had the opportunity to teach the same content using the same science curriculum materials during her first two years, she still drew upon a significant number of external resources to develop the actual curriculum materials she used.

During her third year, Lisa received new science curriculum materials and her curriculum standards changed. As she had noted early in the study, "we were top heavy on science and there's lots to cover" (Lisa, Int. 1.3, 152). While she previously taught nine science units, the new curriculum standards only included five. These changes meant that some topics she had previously taught, including the magnets unit she had constructed and enacted in the previous two years, were no longer included in the fourth grade science curriculum and that different topics had been added. While the increased depth and reduced breadth of topics enabled her to overcome some of the 'coverage' issues she faced before, having new curriculum materials and topics she had never taught before necessitated redeveloping many of the instructional plans she had spent the previous two years constructing. As a result, the pedagogical content knowledge she had developed through curriculum design and enactment for particular topics, as with her magnets unit, became less useful in light of shifting curricular goals for science.

Whitney, on the other hand, had many more opportunities to teach the same electricity and magnets unit over the course of the study, not just each year but multiple times within each year. Iterative cycles of planning, enactment, and reflection served as a crucible for her professional growth. In year two, Whitney wrote,

> As I think about what I am teaching in this unit over and over during the course of the school year, I noticed some key differences this year from last year. I am more prepared this year for each time, and I tend to adapt to the different cultures of the students as they come in. Last year I did the same things each time, and they worked well with some groups of students and not so well with others. This year, if something was not working, I would revisit the concept in a different way the next day and I was more flexible about things in the classroom. I think this may help my students learn the science concepts better…[Some] classes had an advanced knowledge of some of the concepts we covered, so I was able to cover more difficult aspects of what we needed to know with those students. Also, by seeing what they wanted to know, I was more able to tailor the lessons to the classes. (Whitney, Year 2 Journal, 5-20)

Through these experiences, Whitney was afforded the opportunity to develop a better understanding of the content she taught and ways in which to make it accessible to her students.

Teaching the same unit multiple times each year for three years with essentially the same curriculum materials helped her develop robust subject matter knowledge. In assessing her own teaching during her third year, she noted that it was "better just because…I've gotten such a good knowledge base of electricity and magnets" (Whitney, Int. 3.1, 604-605). Her developing subject matter knowledge was directly related to her knowledge of students' ideas about particular curricular content. Though she felt confident with her grasp of subject matter taught, she also described her need to draw on previous enactments to consider "what [subject matter] I need to know, what [students] struggled with, and what I was confused about" (Whitney, Int. 2.3, 246-248). Teaching the same unit to so many different classes allowed her to develop an intricate understanding of how student characteristics can guide curriculum planning, enactment, and mapping, also supporting her development of pedagogical content knowledge.

The three teachers' use of science curriculum materials and related learning was inextricably tied to the contexts in which they took place. For Catie and Lisa, shifting curricular resources for science and district-level science curriculum standards, as well as class size and the professional cultures of their schools, were strong influences on their use of science curriculum materials. Because of these shifting curricular contexts, both teachers were still working to develop unique sets of curricular resources for science that they felt best met the demands of their particular students and classroom contexts. Whitney, on the other hand, had the opportunity to teach the same content repeatedly over the three years of the study, through which she was able to construct and refine particular units that she felt were congruent with her orientation toward science teaching and best met the needs of her students.

Discussion

Each of these three teachers' use of science curriculum materials and learning over the course of the study was influenced by her own orientation toward science teaching and affordances and constraints of her unique school setting. Each experienced a tension between text-based and investigation-based approaches to science teaching and learning and articulated her desire to engage in inquiry-oriented teaching in which both played important roles. In order to more closely approximate this approach to science teaching, each began to supplement her existing science curriculum materials and adapt them to her own classroom. Early on in the study they each quickly developed a design-oriented perspective toward curriculum materials and engaged in varying, though substantial, degrees of localized curriculum design. However, for the teachers in this study, context proved a crucial mediating factor in their professional growth over time related to their use of science curriculum materials. While each of the teachers engaged in similar practices associated with the use of curriculum materials, and held similar perspectives on the nature of effective science teaching, the ways in which their individual curricular contexts facilitated professional growth differed substantially.

These findings add to two distinct but interrelated bodies of research concerned with teachers' use of science curriculum materials (Brown & Edelson, 2003; Enyedy & Goldberg, 2004; Schneider, Krajcik, & Blumenfeld, 2005; Roehrig & Kruse, 2005) and teacher learning during the induction phase of the teacher professional continuum (Feiman-Nemser, 2001; Grossman & Thompson, 2004; Putnam & Borko, 2000). The three new elementary teachers studied here engaged in a substantial degree of curriculum design, drawing on a wide range of science curriculum materials and resources to construct local science curricula that reflected their unique classroom characteristics. They also possessed a sophisticated set of criteria by which they evaluated and adapted existing science curriculum materials to their own unique classroom settings. Their reliance on science curriculum materials they had reinforces the importance of curriculum materials for new teachers (Grossman & Thompson, 2004), and also supports a situated perspective on curriculum mobilization and pedagogical design (Brown, 2002; Brown, in press; Remillard, 2005).

Other researchers have described how teachers use particular curriculum materials, characterizing it as falling along a continuum from faithful enactment to full improvisation (Brown & Edelson, 2003; Remillard, 1999). These teachers' interactions with science curriculum materials consistently fell towards the end of curriculum design spectrum characterized by invention (Remillard, 1999) or improvisation (Brown & Edelson, 2003). In the process of improvising or inventing, the teachers mobilized a vast array of additional curricular resources to construct their own classroom-specific instructional plans that served to guide their science teaching. Our findings extend previous research by illustrating how beginning elementary teachers engage in localized curriculum design using a variety of different science curriculum materials.

For the teachers studied here, curriculum-based learning first required transformation of curricular artifacts from hypothetical instantiations of practice to real, lived classroom experience. These experiences were, in turn, re-instantiated in curricular tools the teachers developed. While objectified artifacts are always inherently imperfect representations (Bourdieu, 1990), expansive learning that leads to fundamentally new ways of doing things is marked by a move from the abstract to the concrete (Engeström, 1987) and can be driven by contradictions that emerge in classroom activity (Ball & Bass, 2000). The curriculum materials the teachers developed became increasingly localized and meaningful tools for them as they were iteratively refined through cycles of design, construction, and post-enactment reflection.

This, however, presents an interesting conundrum. We know that the quality of the changes teachers make to curriculum materials vary (e.g., Enyedy & Goldberg, 2004; Schneider & Krajcik, 2002; Pintó, 2004). While locally-developed curriculum materials may become more meaningful reflections of experience to the teachers themselves, this does not necessarily insure that they will be optimally effective as defined by standards and norms within the field of science education. This is the essential tension at the heart of curriculum development efforts – how to design curriculum materials such that certain fundamental aspects of designed learning experiences remain intact while simultaneously honoring teachers' local knowledge and capacity for curricular decision-making (Author, 2005b; Cohen & Ball, 1999; Fishman & Krajcik, 2003; Fishman et al., 2003).

However, the teachers described particular orientations toward elementary science teaching. These ideas were relatively consistent with those that we draw upon in our teaching of the elementary science methods course in which the three teachers were students, the design of the CASES online environment, and in our ongoing research. Over the course of this study, they worked to put these ideas into practice through their use and development of science curriculum materials. While these results reinforce the importance of teachers' knowledge, beliefs, and identity in their engagement in professional practices, they also suggest that lessons learned in their teacher education program, particularly as related to standards-based, inquiry-oriented science teaching, seem to have had a reasonably long-term impact rather than serving as a marginally-relevant 'weak intervention' (Richardson, 1996).

The teachers' own orientations toward elementary science teaching, then, presented less of an obstacle to effective use of curriculum materials than did, at least in Catie and Lisa's case, the institutional contexts in which they worked. For these two teachers, particularly Catie, science teaching and learning occurred within a context of ongoing curricular change. The start of new school years brought entirely new sets of science curriculum materials or different grade-level science curriculum standards. It is reasonable to assume that no single set of externally-developed curriculum materials will be perfectly suited for any one particular classroom. Curriculum materials development and use is inherently situated, as is the case with all such tools (Engeström, 1987; Greeno et al., 1998; Vygotsky, 1978; Wertsch, 1991). The particulars of these teachers' school settings, including institutional features, students, resource availability, as well as individual teacher characteristics, influenced the degree to which they *appropriated* particular curricular tools (Grossman et al., 1999) and fundamentally influenced their design and development of curricular tools themselves. Our findings suggest that effective appropriation and use of curricular tools would seem to require some degree of stability in which teachers are able to use a select set of science curriculum materials as a foundation for their curriculum design tasks.

Our objective here is not to paint a picture of new elementary teachers facing insurmountable obstacles at every turn. To the contrary, many of these features, including consistently strong curriculum standards and reform-oriented administrators, had a very positive influence on the teachers' socialization to professional teaching. What this discussion does suggest is that these three teachers' learning and development, especially as related to their use of curriculum materials, was both temporal and situated (Feiman-Nemser, 2001; Putnam & Borko, 2000). A crucial aspect of characterizing teacher learning is the delineation of affordances and constraints which strongly influence how they develop in particular settings. These factors influenced their ability to learn from ongoing curriculum design and, ultimately, proved challenging to Catie and Lisa's learning and professional growth. For teachers to learn to use curriculum materials effectively, however, as many features of their unique school settings as possible should be aligned to enable them to do so. Discussions of teacher learning and appraisals of effective teaching should be attuned to the same conditions of learning that are expected for students (Fenstermacher & Richardson, 2005).

Implications

No matter how well-constructed innovative science curriculum materials are, teachers who use them will modify them to some extent. The three teachers in this study drew on a wide variety of curriculum materials and resources and adapted them to their own teaching contexts. These results support the need for flexibly adaptive curricula that are educative for teachers and explicitly support this adaptation process. Since the goal of innovative science curriculum materials development is to promote standards-based, inquiry-oriented science teaching, and because the modifications that teachers make are not always aligned with this goal (Schneider &

Krajcik, 2002), supporting teachers through curriculum materials requires a careful balancing act between highly specified and developed curriculum materials and teachers' professional curricular decision-making (Cohen & Ball, 1999).

Educative curriculum materials, or those designed to explicitly support teachers' learing, can be valuable supports for teachers (Author, 2005b; Ball & Cohen, 1996), particularly beginning teachers (Grossman & Thompson, 2004). The results presented here illustrate issues prioritized by these beginning elementary teachers and can help inform the field's developing understanding of educative curriculum materials development and how teachers use these features. The educative features that help make curriculum materials flexibly adaptive do so by making explicit the purpose of particular design features and promoting student-centered customization of instructional practice (Schwartz et al., 1999). Innovative science curriculum materials should not only objectify phenomena in pedagogically-appropriate ways but to provide teachers, especially new teachers, support for further curriculum mobilization and objectification. These features should be lesson-specific and scaffold not only teachers' expansive learning from the abstract to concrete, or instantiation of conceptual tools into practical tools (Grossman et al., 1999), but also support teachers' generative learning and the construction of experience-based principles of practice (Author, 2005b) or conceptual tools (Grossman et al., 1999). In doing so, they would serve to support the foundational reificative and participative processes that underlie all social activity (Engeström, 1987; Latour, 1999; Wenger, 1998), including that of science teaching and learning.

In order to better prepare prospective elementary teachers for these curriculum design challenges, teacher education should provide preservice teachers with ample opportunities to use curriculum materials in authentic ways. Preservice elementary teachers also have a sophisticated set of criteria by which they evaluate and adapt science curriculum materials (Author, 2006a) and view curriculum design as an authentic and important dimension of elementary science teaching (Authors, in review). Science educators can assist preservice elementary teachers in developing substantial curricular knowledge, or knowledge of curricular goals and associated curriculum materials, which is an important dimension of teachers' pedagogical content knowledge (Grossman, 1990; Magnusson et al., 1999; Shulman, 1986; Zembal et al., 1999). Building knowledge of particular curriculum materials and activities that are effective for promoting student learning is an important part of innovative science teaching (Smith, 1999). Beginning elementary teachers with substantial curricular knowledge and positive orientations toward curriculum design will rely less on 'activities that work' (Appleton, 2003) by being better prepared to confront this time-intensive and challenging dimension of professional practice.

Finally, given the importance of these three teachers' school settings in their use of science curriculum materials, it is necessary to consider ways in which to maximize those contextual features that facilitated and promoted teacher learning and address those that did not. First, while Whitney benefited from her use of a select set of science curriculum materials to teach the same content over the course of the study, Catie and Lisa's changing curriculum contexts proved challenging. While for Catie this was due in part to her decision to move schools, a common occurrence for new teachers (Ingersoll, 2001), it was also a function of curricular decision-making at the school and district level. A greater degree of curriculum stability would support new teachers in developing professional expertise. Second, while curriculum materials helped support these teachers' learning, none of them had any systematic opportunity to work with colleagues around curriculum materials at any point during the study. Unfortunately, as Grossman and colleagues (2001) note, "the simple fact is that the structures for ongoing community do not exist" (pg. 947) in American schools. This is true for preservice teachers as well, who find in their classroom-based experiences that there is limited opportunity and support for the intellectual dimensions of practice (Sim, 2006). It is essential, then, that the formation of materials-based teacher communities be supported, especially for beginning teachers with little to no experience planning with and enacting particular curriculum materials.

Conclusion

Elementary educators face renewed accountability for science teaching and learning through federally-mandated science assessment. The ways in which school districts and schools respond to this changing policy landscape will influence how elementary teachers and students go about daily classroom practices designed to promote science learning and the development of scientific literacy as promoted in current science education reform documents. For teachers, science curriculum materials will remain crucial tools with and through which they engage in science teaching, especially for new teachers with little classroom experience. Even for beginning teachers with reform-minded orientations toward science teaching and positive views about science, curriculum materials use is an aspect of professional practice often characterized by a high level of curriculum design. As illustrated here, this process is situated in particular settings and thus highly influenced by their inherent features. While ongoing science curriculum development efforts will continue to produce curricular tools that support teachers, it is imperative that policy be leveraged in such a way as to foster the kind of school contexts and professional culture in which such tools can be used effectively.

References

American Association for the Advancement of Science (AAAS). (1993). *Benchmarks for Science Literacy*. New York, NY: Oxford University Press.

American Educational Research Association (2006). *AERA Draft Standards for Reporting on Research Methods*. Retrieved March 12, 2006, from http://aera.net/uploadedFiles/Opportunities/StandardsforReportingEmpiricalSocialScience_PDF.pdf

Anderson, R. D., & Mitchener, C. P. (1994). Research on science teacher education. In D. L. Gabel (Ed.), *Handbook of research on science teaching and learning*. New York: Macmillan.

Anderson, L. M., Smith, D.C., & Peasley, K. (2000). Integrating learner and learning concerns: Prospective elementary science teachers' paths and progress. *Teaching and Teacher Education, 16*(5-6), 547-574.

Appleton, K. (2003). How do beginning primary school teachers cope with science? Toward an understanding of science teaching practice. *Research in Science Education, 33*, 1-25.

Appleton, K., & Kindt, I. (2002). Beginning elementary teachers' development as teachers of science. *Journal of Science Teacher Education, 13*(1), 43-61.

Author (2004a). In *Research in Science Education.*

Author (2004b). In W.A. Sandoval In Y.B. Klafai, N. Enyedy, A.S. Nixon & F. Herrera (Eds). *Proceedings of the 6th International Conference of the Learning Sciences*, *ICLS 2004*. Mahway, NJ: Lawrence Erlbaum Assoc.

Author (2004c). In W. A. Sandoval Y. B. Kafai, N. Enyedy, A. S. Nixon & F. Herrera (Eds.), *Proceedings of the 6th International Conference of the Learning Sciences, ICLS2004*. Mahwah, NJ: Lawrence Erlbaum Assoc.

Author (2005a). In *Journal of Science Teacher Education.*

Author (2005b). In *Educational Researcher*

Author (2006a). In *Science Education*

Author (2006b). In S. Barab, K. Hay & D. Hickey (Eds.), *The Proceedings of the 7th International Conference of the Learning Sciences*. Mahwah, NJ: Lawrence Erlbaum Associates.

Author (2006c). In *Review of Educational Research*

Authors (in press). In *Science & Education*.

Authors (in review). Exploring preservice elementary teachers' role identity development in respect to the use of science curriculum materials.

Ball, D. L., & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J. Boaler (Ed.), *Multiple perspectives on the teaching and learning of mathematics*. Westport, CT: Ablex.

Ball, D. L., & Cohen, D. K. (1996). Reform by the book: What is—or might be—the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher*, 25(9), 6-8, 14.

Barab, S.A. & Luehmann, A.L. (2003). Building sustainable science curriculum: Acknowledging and accomodating local adaptation. *Science Education, 87*, 454-467.

Bolin, F. (1987). The teacher as curriculum decision maker. In F. Bolin & J. Falk (Eds.), *Teacher Renewal: Professional issues, personal choices* (pp. 92-108). New York: Teachers College Press.

Bourdieu, P. (1990). *The Logic of Practice*. Stanford, CA: Stanford University Press.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (1999). *How People Learn: Brain, Mind, Experience, and School*. Washington, DC: National Academy Press.

Brown, M. (in press). Toward a theory of curriculum design and use: Understanding the teacher-tool relationship. In B. Herbel-Eisenman J. Remillard, and G. Lloyd (Eds). *Teachers' use of mathematics curriculum materials: Research perspectives on the relationship between teachers and curriculum*.

Brown, M. (2002). *Teaching by Design: Understanding the Interaction between Teacher Practice and the Design of Curricular Innovations*. Doctoral Dissertation, Northwestern University

Brown, M., & Edelson, D. (2003). *Teaching as design: Can we better understand the ways in which teachers use materials so we can better design materials to support their changes in practice?* (Design Brief). Evanston, IL: The Center for Learning Technologies in Urban Schools.

Bryan, L.A. (2003). Nestedness of beliefs: Examining a prospective elementary teacher's belief systems about science teaching and learning. *Journal of Research in Science Teaching, 40*(9), 835-868.

Bullough, R.V., Jr., Knowles, J.G., & Crow, N.A. (1992). *Emerging as a teacher*. New York: Routledge.

Clandinin, D. J., & Connelly, F. M. (1998). Stories to live by: Narrative understandings of school reform. *Curriculum Inquiry, 28*(2), 149–164.

Cohen, D. K., & Ball, D. L. (1999). *Instruction, capacity, and improvement* (CPRE Research Report Series RR-043). Philadelphia, PA: University of Pennsylvania Consortium for Policy Research in Education.

Collopy, R. (2003). Curriculum materials as a professional development tool: How a mathematics textbook affected two teachers' learning. *The Elementary School Journal, 103*(3), 227-311.

DeBoer, G.E. (1991). *A history of ideas in science education: Implications for practice*. New York, NY: Teachers College Press.

Donmoyer, R. (2001). Paradigm talk reconsidered. In V. Richardson (Ed.) *Handbook of research on teaching*. (pp. 174-197). Washington D.C.: AERA.

Drake, C. & Sherin, M. G. (2006). Practicing change: Curriculum adaptation and teacher narrative in the context of mathematics education reform. *Curriculum Inquiry, 36*(2), 153-187.

Drake, C., Spillane, J.P., & Hufferd-Ackles, K. (2001). Storied identities: teacher learning and subject-matter context. *Journal of Curriculum Studies, 33*(1), 1-23.

Eisenhart, M., & Howe, K. (1992). Validity in educational research. In M. LeCompte, W. Millroy, & J. Preissle (Eds.), *Handbook of qualitative research in education*. (pp. 643-680). New York: Academic Press.

Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki: Orienta-Konsultit.

Enyedy, N. & Goldberg, J. (2004). Inquiry in interaction: How local adaptations of curricula shape classroom communities. *Journal of Research in Science Teaching, 41*(9), 905-935.

Enyedy, N., Goldberg, J., & Welsh, K.M. (2006). Complex dilemmas of identity and practice. *Science Education, 90*, 68-93.

Feiman-Nemser, S (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record, 103*(6), 1013-1055.

Fenstermacher, G.D. & Richardson, V. (2005). On making determinations of quality in teaching. *Teachers College Record, 107*(1), 186-213.

Fishman, B.J. & Krajcik, J. (2003). What does it mean to create sustainable science curriculum innovations? A commentary. *Science Education, 87*, 564-573.

Fishman, B., Marx, R., Best, S., & Tal, R (2003). Linking teacher and student learning to improve professional development in systemic reform. *Teaching and Teacher Education, 19*(6), 643-658.

Goldston, D. (2005). Elementary science: Left behind? *Journal of Science Teacher Education, 16*(3), 185-187.

Greeno, J. and the Middle School Mathematics Through Application Project Group (1998). The situativity of knowing, learning, and research. *American Psychologist, 53*(1), 5-26.

Grossman, P. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College Press.

Grossman, P., Smagorinsky, P., & Valencia, S. (1999). Appropriating tools for teaching English: A theoretical framework for research on learning to teach. *American Journal of Education, 108*(1), 1-29.

Grossman, P., & Thompson, C. (2004). *Curriculum materials: Scaffolds for teacher learning*? (No. R-04-1). Seattle: Center for the Study of Teaching and Policy.

Grossman, P., Wineburg, S., & Wollworth, S. (2001). Toward a theory of teacher community. *Teachers College Record, 103*(6), 942-1012.

Haney, J.J., Lumpe, A.T., Czerniak, C.M., & Egan, V. (2002). From beliefs to actions: The beliefs and actions of teachers implementing change. *Journal of Science Teacher Education, 13*(3), 171-187.

Haney, J.J. & McArthur, J. (2002). Four case studies of prospective science teachers' beliefs concerning constructivist teaching practices. *Science Education, 86*(6), 783-802.

Ingersoll, R.M. (2001). Teacher turnover and teacher shortages: An organizational analysis. *American Educational Research Journal, 38*(3), 499-534.

Interstate New Teacher Assessment and Support Consortium (INTASC). (1992). *Models standards for beginning teacher licensing and development: A resource for state dialogue*. Washington, DC: Council of Chief State School Officers.

Johnson, R. B. (1997). Examining the validity structure of qualitative research. *Education, 118*, 282-292.

Kauffman, D., Johnson, S.M., Kardos, S.M., Liu, E., & Peske, H. (2002). "Lost at sea": New teachers' experiences with curriculum and assessment. *Teachers College Record, 104*(2), 273-300.

Krefting, L. (1991). Rigor in qualitative research: The assessment of trustworthiness. *The American Journal of Occupational Therapy, 45*, 214-222.

Latour, B. (1999). *Pandora's hope: Essays on the reality of science studies*. Cambridge, MA: Harvard University Press.

Lloyd, G. (1999). Two teachers' conceptions of a reform-oriented curriculum: Implications for mathematics teacher development. *Journal of Mathematics Teacher Education, 2*, 227-252.

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In In J. Gess-Newsome & N. Lederman (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education* (pp. 95-132). The Netherlands: Kluwer Academic Publishers.

Marx, R. & Harris, C. (2006). No Child Left Behind and science education: Opportunities, challenges, and risks. *Elementary School Journal, 106*(5), 467-477.

Miles, M.B, and Huberman, A.M. (1994). *Qualitative Data Analysis*. (2nd Ed.). Newbury Park, CA: Sage.

National Council for Accreditation of Teacher Education (NCATE). (1987). *NCATE standards, procedures, and policies for the accreditation of professional education units: The accreditation of professional education units for the preparation of professional school personnel at basic and advanced levels*. Washington, DC: National Council for Accreditation of Teacher Education.

National Council for the Social Studies (NCSS). (1994). *Expectations of excellence: Curriculum standards for social studies*. Washington, DC: National Council for the Social Studies.

National Council of Teachers of Mathematics (NCTM). (1991). *Professional teaching standards for teaching mathematics*. Reston, VA: National Council of Teachers of Mathematics.

National Research Council (NRC). (1996). *National science education standards*. Washington, DC: National Research Council.

National Research Council (2000). *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning*. Washington, D.C.: National Academy Press.

Nye, B., Konstantopoulos, S, & Hedges, L.V. (2004). How large are teacher effects? *Educational Evaluation and Policy Analysis, 26*(3), 237-257.

Pintó, R. (2004). Introducing curriculum innovations in science: Identifying teachers' transformations and the design of related teacher education. *Science Education, 89*(1), 1-12.

Putnam, R.T. & Borko, H (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4-15.

Remillard, J.T. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research, 75*(2), 211-246.

Remillard, J. T. (2000). Can curriculum materials support teachers' learning? Two fourth-grade teachers' use of a new mathematics text. *Elementary School Journal, 100*(4), 331–350.

Remillard, J. T. (1999). Curriculum materials in mathematics education reform: A framework for examining teachers' curriculum development. *Curriculum Inquiry, 19*(3), 315-342.

Remillard, J.T. & Bryans, M.B. (2004). Teachers' orientations toward mathematics curriculum materials: Implications for teacher learning. *Journal of Research in Mathematics Education,* 35(5), 352 - 388.

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula, T. Buttery, & E. Guyton (Eds.), *Handbook of research on teacher education* (pp. 102-119). New York: Macmillan.

Roehrig, G.H. & Kruse, R.A. (2005). The role of teachers' beliefs and knowledge in the adoption of a reform-based curriculum. *School Science and Mathematics, 105*(8), 412-422.

Rosebery, A. & Puttick, G. (1998). Teacher professional development as situated sense-making: A case study in science education. *Science Education, 82*, 649-677.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Schneider, R., & Krajcik, J. (2002). Supporting science teacher learning: The role of educative curriculum materials. *Journal of Science Teacher Education, 13*(3), 221-245.

Schneider, R.M., Krajcik, J., & Blumenfeld, P. (2005). Enacting reform-based science materials: The range of teacher enactments in reform classrooms. *Journal of Research in Science Teaching, 42*(3), 283-312.

Schwarz, C., Gunckel, K., Smith, E., Covitt, B., Enfield, M., Bae, M., & Tsurusaki, B. (in review). Helping elementary pre-service teachers learn to use science curriculum materials for effective science teaching.

Scharwtz, D., Lin, X., Brophy, S, & Bransford, J. (1999). Toward the development of flexibly adaptive instructional design. In C. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 183- 214). Mahwah, NJ: Lawrence Erlbaum Assoc.

Sim, C. (2006). Preparing for professional experiences - incorporating pre-service teachers as 'communities of practice'. *Teaching and Teacher Education, 22*, 77-83.

Smith, D.C. (1999). Changing our teaching: The role of pedagogical content knowledge in elementary science. In J. Gess-Newsome & N. Lederman (Eds). *Examining pedagogical content knowledge: The construct and its implications for science education* (pp. 163-197).The Netherlands: Kluwer Academic Publishers.

Smith, L. & Gess-Newsome, J. (2004). Elementary science methods courses and the National Science Education Standards: Are we adequately preparing teachers? *Journal of Science Teacher Education, 15*(2): 91-110.

Southerland, S.A. & Gess-Newsome, J. (1999). Preservice teachers' views of inclusive science teaching as shaped by images of teaching, learning, and knowledge. *Science Education, 83*(2), 131-150.

Spillane, J. P., Diamond, J. B., Walker, L., Halverson, R., & Jita, L. (2001). Urban school leadership and elementary science instruction: Identifying, mobilizing, and activating resources in a devalued subject area. *Journal of Research in Science Teaching, 38*(8), 918–940.

Squire, K.D., Makinster, J., Barnett, M., Barab, A.L., & Barab, S.A. (2003). Designed curriculum and local culture: Acknowledging the primacy of classroom culture. *Science Education. 87*, 1– 22.

Strauss, A. & Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks, CA: Sage.

Valencia, S., Place, N., Martin, S., & Grossman, P. (2006). Curriculum materials for elementary reading: Shackles and scaffolds for four beginning teachers. *The Elementary School Journal, 107*(1), 93-120.

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes*. London, England: Cambridge University Press.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge: Cambridge University Press.

Wertsch, J. V. (1991). *Voices of the mind: A sociocultural approach to mediated action*. Cambridge, MA: Harvard University Press.

Zembal, C., Starr, M., & Krajcik, J. (1999). Constructing a framework for elementary science teaching using pedagogical content knowledge. In J. Gess-Newsome & N. Lederman (Eds). *Examining pedagogical content knowledge: The construct and its implications for science education* (pp. 237-256). The Netherlands: Kluwer Academic Publishers.

Endnotes

[1] Quotes from participant interviews are labeled as name [pseudonym], Int. [year.interview #], [line number(s) from transcribed document]

[2] Quotes from participant journal entries are labeled name [pseudonym], Year [year] Journal, [line number(s) from document]

Appendix
Examples of Coded Text

Use of curriculum materials – general – design
Um, the first time I did it all, I, there was a video that came with the software kit, so I kind of tried to figure out all these experiments, what the kids are going to have to do with the videos. Cause sometimes when I was reading the directions I was like, I was like, what do they mean by this? So I watched the video like that showed how to do everything. But I made sure that I knew how to do everything. (Whitney, Int. 1.3, 245-249)

Use of curriculum materials – general - construction
And then I think the day before that, I forgot to tell you, we went through what is magnetic and what is not. And so we, I think that had, like thirteen or fifteen objects in a tin and I had, like, six groups. And I showed them all and I made sure they knew that it was called and they had to write it down and make a table. Then they tested them all and wrote yes or no. And then we went through it and I had them come up with any generalizations. Do you see anything in common, wooden objects are non magnetic. So in the book they were just making general observations. (Lisa, Int. 1.1, 624-630)

Use of curriculum materials – general – curriculum mapping
I: You said you went to your binder and looked at the objectives with those, the objectives that you had written down last year.
L: No, they were actually, I think my curriculum has like four points that the kids needed to know. After I read it, I like wrote them down, like the kids need to know north and south pole, they need to know magnet force travels through objects. They need to know, you know, north and south attract, and then one other, and so that's how I based my labs, each lab focused on one objective. (Lisa, Int. 2.1, 85-87)

Use of curriculum materials – CASES – design
W: I used parts of it. I took some of the lessons that were similar to what I had and modified some of mine and used parts of them but I didn't use everything (10)
I: Right, okay. So would you say that you used the outline of the unit or would you say that the unit you taught was pretty similar to other units you taught except for you used Kasis lessons.
W: I'd say it's more similar to what I did because I started with, like, the one on there starts with electricity and goes to magnets later. The other ones did magnets first…electricity and then tied

them together. So I kind of still used the format of what I had but used some of the lesson and ideas from Kasis. (Whitney, Int. 1.1, 11-23)

Use of curriculum materials – CASES – construction
The first thing we did was we looked at bird beaks, which is, I mean it's not a big thing, like big changes that I made, but I broke everything down. And the first thing that we did was look at the bird beaks. We looked at them individually. I took 12 pictures off of one of the Internet sites that was mentioned in the lesson and showed each of those beaks, and we looked at them, and we predicted what we thought each bird beak would eat. And then they went through and did the experiment, like is outlined in the lesson, and then at the end we talked as a group about what we found out, and we gathered all of our information into a chart, and then we made a final decision of what we thought each bird in those pictures would have eaten. (Catie, Int. 2.1, 201-209)

Use of curriculum materials – CASES – curriculum mapping
We did, I'd first talk about the plant part. How do humans get their food. So I had them, you know, like, I always have them think of ideas first. So I think I said, how do humans get their food, was the question of the day. And then I had them list down some ideas and then we'd talk about it. And then we'd talk about the plants and I put a picture of a plant on the overhead and they had to name them. And since I knew that they'd already had plant parts before. I don't have to touch upon it (231) in my curriculum. But I did it really quick. And so then that took us on to what consumerism produces. And then that got into the food thing. And I didn't do photosynthesis because we didn't have to. It wasn't in my curriculum. So that whole part of the CASES unit I just skipped right over. (Lisa, Int. 1.2, 428-440)

Perspective on science teaching practice
Effective science teaching? Well in general I think that you know being in a society that's so geared towards standards, taking MEAP's and Iowa's and just test taking in general I think that idealistically you would want the kids to be doing hands on all the time but realistically it's not possible and it's very time consuming. You know we're almost done with our second quarter and that's halfway through the year and I feel we haven't been in school that long at all. I think that it's important for the kids to do some book reading and test taking, just their knowledge on that. I try in my classroom now, I try not to make that the center focus. (Catie, Int. 1.1, 304-309)

Context
I: So your school does give you pretty specific objectives of what you're supposed to be teaching?

L: Um, yeah. What they did is, they did a good job separating it up and they'll have, relating it to what we learned a Michigan, they'll have a unit question. And then they'll give you some activities you can do. And it'll say like "assessment" and it might just list off little things but it doesn't give you anything of what they're talking about. So, for instance, I'm doing recycling right now. And one of the assessments is kids make up a recycling plan. And then that's all they give you.
I: Okay. So those are the materials that the district gave you as far as standards and stuff.
L: Um hmm. (Lisa, Int. 1.1, 80-90)

Table 1
Coding Scheme for Thematic Analysis

Code	Description
General Use of Science Curriculum Materials	
Design	Teachers' interactions with curriculum materials in absence of students
Construction	Teachers' interactions with curriculum materials in presence of students
Curriculum Mapping	Organization of the curriculum over time
Use of CASES Curriculum Materials	
Design	Teachers' interactions with CASES curriculum materials in absence of students
Construction	Teachers' interactions with CASES curriculum materials in presence of students
Curriculum Mapping	Organization of the CASES curriculum over time
Perspectives on Science Teaching	Espoused knowledge and beliefs about science teaching and learning
Context	Relevant to teachers' use of curriculum materials – includes instructional time, opportunities for repeated enactment, prioritization of science teaching, availability of supporting resources, etc.