Novice and Expert Teachers’ Conceptions of Learners’ Prior Knowledge

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ABSTRACT: This study presents comparative case studies of preservice and first-year teachers’ and expert teachers’ conceptions of the concept of prior knowledge. Kelly’s (The Psychology of Personal Construct, New York: W.W. Norton, 1955) theory of personal constructs as discussed by Akerson, Flick, and Lederman (Journal of Research in Science Teaching, 2000, 37, 363–385) in relationship to prior knowledge underpins the study. Six teachers were selected to participate in the case studies based upon their level experience teaching science and their willingness to take part. The comparative case studies of the novice and expert teachers provide insights into (a) how novice and expert teachers understand the concept of prior knowledge and (b) how they use this knowledge to make instructional decisions. Data collection consisted of interviews, classroom observations, and document analysis. Findings suggest that novice teachers hold insufficient conceptions of prior knowledge and its role in instruction to effectively implement constructivist teaching practices. While expert teachers hold a complex conception of prior knowledge and make use of their students’ prior knowledge in significant ways during instruction. A second finding was an apparent mismatch between the novice teachers’ beliefs about their urban students’ life experiences and prior knowledge and the wealth of knowledge the expert teachers found to draw upon.

INTRODUCTION

Multiple studies of preservice science teachers have found that, despite methods courses and teacher preparation programs based on constructivist learning theory, students find it difficult to implement appropriate instructional practices to support constructivist learning in their classrooms (Adams & Tillotson, 1995; Haney & MacArthur, 2002; Marion et al., 1999; Meyer et al., 1999). Whether the methods courses have focused on particular instructional strategies such as conceptual change (Martens & Crosier, 1994; Shymansky, 1992; Tabachnick & Zeichner, 1999), or offered a diverse set of constructivist instructional practices (Erickson et al., 1994; Northfield, Gunstone, & Erickson, 1996; Salish, 1997) few
beginning teachers are able to make effective use of them. As science teacher educators we continue to search for research findings and methods courses that close the gap between what science teacher educators know to be good practice and what novice teachers are able to do in their classrooms.

Ausubel’s (1968) statement, “[t]he most important single factor influencing learning is what the learner already knows; ascertain this and teach him[her] accordingly” (p.iv), re-focused how educators thought about teaching and learning. If we agree with placing the learners’ prior knowledge as the central feature of constructivist learning, then science education programs should insure that preservice teachers are able to ascertain their students’ prior knowledge and teach accordingly. However, given prior knowledge’s central role in learning, there is a surprising lack of research that explores how teachers—preservice and in-service—understand the concept of prior knowledge and make instructional decisions based upon their understanding. Windschitl (2002) acknowledges this in his review of research on constructivist teaching practices; “The most profound challenges for teachers are not associated merely with acquiring new skills but with making personal sense of constructivism as a basis for instruction . . . . There is little literature that probes, systematically or in depth, the full scope of challenges faced by teachers in creating constructivist classrooms” (p. 131). Nor is there much evidence in the literature to suggest that teacher preparation programs explicitly guide preservice teachers to develop their conceptions of prior knowledge. Teacher education programs have begun to address preservice teachers’ beliefs about students, teaching, and multicultural issues (Bryan & Abell, 1999; Bryan & Atwater, 2002; Hollingsworth, 1989; Tobin & LaMaster, 1995), all of which reinforce our need to gain a better understanding of how preservice teachers understand prior knowledge and its role in student learning. There seems to be an assumption that by simply stating to preservice teachers that prior knowledge is important means that they will believe it, and that they will know how to integrate it into their instructional practices.

Haney and McArthur (2002) suggest, “studies examining the constructivist beliefs of teachers are necessary to understand a teacher’s journey as they attempt to implement constructivist teaching and learning practices” (p. 784). The exploratory study reported here involved novice and expert teachers and explored how the core constructivist concept of prior knowledge was understood and acted upon by these teachers.

THEORETICAL UNDERPINNINGS

Akerson, Flick, and Lederman (2000), who studied primary science teachers’ ability to recognize students’ prior conceptions and then instruct based upon them, used Kelly’s (1955) theory of personal constructs as their basis for a definition of prior knowledge. In Kelly’s view, human’s most basic psychological function is to organize experienced events into themes that can be used to predict future events based upon their similarity to and difference from past events. Prior knowledge is the organizing factor of individuals’ thought processes. New experiences are integrated into these organized thought patterns and establish the basis upon which learners make inferences about new and future events in an attempt to maintain a stable worldview (Ackerson, Flick, & Lederman, 2000). In this framework for understanding prior knowledge, learners’ ideas about the world are defined as experience-based explanations (emphasis mine) that each learner constructs so that a wide range of events and objects can be made intelligible (Wandersee, Mintzes, & Novak, 1994). This framework for science learning and teaching was described by Strike and Posner (1992) in their revision to their theory of conceptual change; “Our theory of conceptual change concerns the alteration of conceptions that are in some way central and organizing in thought and learning” (p. 148). Teaching then requires teachers who understand students’
existing conceptions and can create learning experiences that will allow students to either accommodate or restructure their knowledge frameworks for new learning.

Current research on teacher learning conceives of the role of prior knowledge for teaching in similar fashion, experience-based knowledge of teaching, gained through years of partial apprenticeship as students in classrooms. These experiences are used to guide new teachers’ practices, whether or not, as students the preservice teachers were observing teachers with expertise in implementing constructivist learning practices. This research suggests that new teachers’ development is highly dependent upon their beliefs—conceptions and understandings—of central concepts in education and their ability to put them into practice (Barmald, Hardman, & Leat, 1995; Bryan & Abell, 1999; Bryan & Atwater, 2002; Rich & Almozlino, 1999; Sutton et al., 1996; Taylor & Sobel, 2001). If novice teachers do not hold a sufficient conception of prior knowledge, one that includes the importance of their students’ prior experiences as well as prior learning, they cannot effectively create and support constructivist learning even if they do believe and accept its central role in learning. Haney and McArther (2002) predicted for the preservice teachers in their study when their core beliefs were insufficient the teachers experienced frustration and failure which increased the likelihood that they would disregard the strategies they perceived to be problematic. Therefore, it is important to study not only preservice and new teachers’ conceptions of prior knowledge, but also long-term successful teachers to understand where similarities and differences lie in their conceptions, and develop programs that help novice teachers develop appropriate conceptions.

The process of learning to teach is complex and novices are limited by their lack of background experiences as educators and therefore have limited frameworks for making sense of what is happening in their classrooms. Research in learning to teach has made clear, that “expertise and experience are not identical, but . . . experience is a necessary component of expertise” (Rich & Almozlino, 1999). Currently the question remains, how does experience become expertise? Past research has informed us about differences in novices’ and experts’ thinking in other performance domains. Within a novice–expert framework, novices are characterized as having a restricted and poorly organized knowledge base. They perceive events and process the meanings of those events narrowly, which limits their problem-solving ability. Finally, their knowledge exists in rigid semantic and procedural structures (Berliner, 1994; Sternberg & Horvath, 1995). The novices lack experiences to organize their thinking into useful constructs for making predictions about future events. Experts, on the other hand, have well-developed knowledge bases and organizations that are responsive to multiple external and internal cues and are highly linked allowing for flexible patterns of organization and problem solving. Because of this, experts continue to develop expertise and knowledge, “in the ongoing process in which knowledge is used, transformed, enhanced, and attuned to situations” (Bereiter & Scardamalia, 1993). The practice of expert teachers can be seen as a balance between teaching as art and teaching as science. When watching expert teachers, their actions and interactions in the classroom seem to be remarkably intuitive, they just know what to do or what to say. Larkin et al. (1980) similarly describe physics experts as those who, “can often solve difficult problems rapidly and without much conscious deliberation about a plan of attack” (p. 1335). But they caution that to just admit that some individuals have greater intuition is only the “prelude to demanding an explanation for it. How does it operate, and how can it be acquired?” (Larkin et al., p. 1335). In order to do so we must begin to get at the question asked by Peterson and Comeaux (1987), “how does this teaching intuition work?” As teacher educators we cannot simply hold that some students will intuitively become expert teachers, rather we want all teachers to develop expert knowledge systems for accessing and organizing their thinking about classroom practices. However, in order to do
this we need to be able to describe the differences not only in what expert teachers do in classrooms, but in how they determine which actions to take when faced with a classroom of students. In teacher education we must unpack what it means to be an intuitive teacher.

Smith (2000) articulates this for her elementary science methods class. She explains how she has developed an understanding of her preservice teachers’ prior knowledge, then uses this knowledge to guide her practice. She provides initial evidence of how intentionally structured expert teaching is, although it may seem intuitive to an observer. To achieve an intuitive feel in her teaching she intentionally designs her class to address her preservice elementary teachers’ prior knowledge in science and then uses this as a basis for instruction.

**DESIGN AND PROCEDURES**

This exploratory research was designed to understand the difference in (a) what teachers—novice and expert—understood about prior knowledge as a concept and (b) to understand if and how they acted on their understanding in classroom situations. An exploratory design was used as initial patterns of knowledge and practice were being targeted to generate more specific hypotheses for future research and teaching (Marshall & Rossman, 1995). The research was conducted in the urban-focused teacher education program in a large Midwestern urban university at which the researcher worked. This study was part of an on-going study focused on how the contrasting backgrounds of the preservice teachers and the urban youth in the schools they were placed in affected how novice teachers learned to teach and how their beliefs about teaching changed over time with the intention of improving instruction in the methods class in order to close the preservice teachers’ knowledge gaps.

The research participants included two preservice teachers, two first-year teachers, and two expert teachers. The preservice and first-year teachers were students in the researcher’s courses who were selected from a larger pool of volunteers based upon the participants’ availability and school location. All four of the novice teacher participants had entered into secondary education as post-baccalaureate students with degrees in one of the sciences. Their preparation program involved 1 year of professional education classes with two 60 h field experiences and a 1-year teaching internship. The preservice teachers in the study were completing their professional year of study and observed during their second field experience. The first-year teachers were completing their teaching internship with the researcher serving as their university supervisor. Teaching interns have full responsibility for a half-time teaching load and were considered, and paid by the schools, as first-year teachers. Both of the preservice and one of the first-year teachers had been through the researcher’s secondary science methods class, which emphasized the role of prior knowledge in learning. In this class they had read Osborne and Freyberg’s (1985) *Learning in Science* and had taken part in four instructor led demonstrations. The purpose of the demonstrations was to model obtaining students’ conceptual prior knowledge. The other first-year teacher had been through another instructor’s methods course.

The two expert teachers were selected from a pool of university mentor teachers with whom the researcher worked. The criteria for expertise included years of teaching experience, educational degrees, professional development, and experience working with new teachers. Both of the expert teachers had more than 10 years teaching experience in urban schools. Both had a Master’s degree and one was National Board Certified in secondary science. Both had served in advisory positions for the school district and had developed and run science curriculum professional development activities at the school and district level.
In the summer prior to this study, the researcher and the two expert teachers had participated in an infusing technology into science instruction workshop that required each participant to adapt lessons for technology. All the participants voluntarily agreed to participate in the study.

All participants completed two standard semistructured interviews that were audiotaped and transcribed. The first interview established their understanding of prior knowledge. In this interview the participants were asked how they defined prior knowledge, the role they thought it played in learning, how it was talked about in classes or in professional development programs, and how they used it in their teaching. In the second interview the participants discussed planning to teach a unit on density. They were asked what they anticipated their students knowing about density before teaching, where they thought students had learned about density, if they thought their students had out-of-school experiences with density that might be useful, and what clues they listened for in their students to help them understand what their students already knew about density.

These standard interviews were initially coded into the two broad categories defined by the two research purpose: (a) how do teachers understand the concept of prior knowledge and (b) how do they use this in their teaching. Coding in the first category was established to be able to compare the participants’ views with Kelly’s (1955) personal constructs theory; prior knowledge comes from experience and is used to make predictions about future events (learning). The specific coding categories were (a) how students obtain prior knowledge and (b) the role of prior knowledge in students’ learning. The second broad category focused on teaching and included (c) how teachers can find out about students’ prior knowledge and (d) how teachers should use students’ prior knowledge. The researcher read and coded each interview transcript using these four initial categories. Once coded into broad categories the interviews were reread looking for smaller subcategories that shaped the boundaries of the participants’ meanings of prior knowledge.

After these initial subcategories were developed, all the participants were observed teaching at least one lesson; lesson plans, hand-outs, and other planning materials were collected after the observations. The observations were followed by an informal interview focused on how the teacher thought the lesson went and if they were surprised by anything during the lesson. These informal interviews were not audiotaped; however, field notes were taken. The focus of the observation was on if, when, and how the teachers attended to students’ prior knowledge. When they were observed attending to prior knowledge, the type of prior knowledge the teachers asked about was considered. A running record of questions asked by the teacher and type of student response—factual, example, or explanation—was kept. The observation categories were derived from the interview patterns and used to compare the teachers’ ideas and actions. Additional data sources, such as self-assessments and curriculum planning documents, were gathered from the participants as part of their nonteaching interactions with the researcher and used for further clarification of the teachers’ ideas and actions.

FINDINGS

What Do Teachers Understand Prior Knowledge To Be?

In order to understand what teachers understood about prior knowledge, two broad ideas were focused on, where does prior knowledge come from, and what role does prior knowledge play in student learning. The preservice and first-year teachers identified three ways that students obtain prior knowledge, including prior teaching, informal learning experiences, such as TV shows or museums, and general life experiences. Both first-year and
one preservice teacher also believed that students could lack prior knowledge completely. Within these four categories, the novice teachers felt most strongly that students’ prior knowledge was the result of prior formal teaching or other forms of informal teaching. Since prior teaching was the primary source of prior knowledge for the novices, their belief that students may lack prior knowledge is sensible. This reliance on prior teaching is exemplified by the following quotes:

I think well hopefully, I mean, they have by that grade studied some of this before in school. (Angela, PS, Int. 2)

I would imagine they have gone from . . . discussed chemical densities and molecular densities and probably building on their own science knowledge, which would be from a freshman or sophomore course. (Ben, PS, Int. 2)

I have covered those before we covered density. I tried not to assume a whole lot of things because when you assume they know something it just goes right over their heads. Skip over it—they skip over it. (Jimmy, FY, Int. 2)

Lesson observations of Ben (PS) and Sara (FY) found they acted upon this belief by explicitly asking students to recall previous instruction as the sole connection to what they were going to cover. Ben asked his students to recall the laboratory activity that had explained the temperature–pressure relationship of the gas law. Sara referred her tenth grade chemistry students to their eighth grade physical science class when they had learned about different chemical reactions. This helping students to specifically recall when they had covered the concepts in prior instruction maybe useful, but neither of the teachers asked the students to explain the relationship of the new material to what was previously learned or even what they remembered or understood from that previous instruction.

In contrast to the novice teachers, the expert teachers rarely mentioned their students’ prior classes or informal learning experiences as being a primary source for prior knowledge. The expert teachers discussed everyday life experiences that students have observed and possibly have partial explanations for as their primary basis for prior knowledge.

They can explain or see what density does and how density works in real life situations I think they have a sense of why certain things float and other things sink. (Barbara, E, Int. 2)

When they discussed prior teaching about a topic they were interested in having the students relate examples or tie ideas together based on the previous instruction.

Eighth graders, who have heard of it before and they are just firming up and seeing more examples of how density plays in with all of the [science] disciplines. (Barbara, E, Int. 2)

Barbara’s teaching observation illustrated how she used students’ prior knowledge from everyday events and prior teaching to get her students to apply the concepts of density to learning about convection currents. She used two boxes of the same size with different numbers of x’s drawn in each box. She then asked her students, “what have we used this diagram to explain?” As a group they recalled density and the model of it from earlier classes. She then asked her students to think about boiling water, draw a diagram of it, and use x’s as water molecules to explain what we would see in the water and in the bubbles. She then went on to discuss currents created by temperature differences (observation notes).
The expert teachers were more likely ask students to use previous instruction to explain real life situations before going on to new materials.

The differences in the novices’ and experts’ beliefs about how prior knowledge is obtained led to different ideas about how prior knowledge impacts learning. In this area preservice and expert teachers agreed that prior knowledge could either facilitate or hinder new learning depending upon how closely the students’ prior knowledge matched the learning expectations of the teacher. Neither first-year teacher mentioned students’ misconceptions as a problematic aspect of prior knowledge. The preservice teachers had just read Osborne and Freyberg’s book *Learning in Science* (1985) and used this as a reference point for discussing students’ misconceptions about basic science ideas; however, only the experts moved beyond simply identifying misconceptions to actively addressing them in their teaching.

I think that’s the thing kids can get confused by that. Um, weight is part of density. (Angela, PS, Int. 1)

Maybe appreciate what it [density] does, it maybe across different things, but maybe we were talking about the same thing with different ideas in mind. (Ben, PS, Int.1)

But most kids will say it [density] has something to do with weight. So we have [pause] and then I know I have to kind of really go from the mass standpoint. (Kate, E, Int.1)

If they give a funny answer to a question then I am going to do it differently . . . find out what they are really confused about. (Barbara, E, Int. 1)

When preservice and first-year teachers discussed how students’ prior knowledge facilitates learning, they held a very limited view of its importance for learning. This seemed particularly true of the first-year teachers who indicated that the overriding role of prior knowledge was for engagement, whether it was to engage the class in learning a new topic or to teach skills. For example, first-year teacher Jimmy was observed using candy to teach his students how to make concept maps then moving to making concept maps of atomic structures. In the follow-up interview Jimmy was happy the students had been so engaged making the concepts maps of candy (field notes). Similarly, first-year teacher Sara used KWL activities at the start of each unit. She explained “they like doing the KWLs because then they know what they have to learn” (Sara, FY, Int. 1). For these first-year teachers the importance of prior knowledge was less for learning than for instruction.

All participants spoke of the role that prior knowledge played in providing the material onto, or with which, new knowledge could be built. However, the role of prior knowledge as a building material for the novices and experts differed markedly. The novices saw prior knowledge as the information base upon which new information could be added. Put differently, prior knowledge was like a building foundation and new knowledge was like bricks of information added to the construction.

[Prior knowledge] is important in planning because you don’t want to start a lesson too far ahead of where the curve is. You kind of want to bring the curve along. So you have to start at what they last learned. (Ben, PS, Int. 1)

Yeah, it’s just what they’re coming to class equipped with . . . Some have power windows and some need to have power windows installed before they can learn new stuff. (Jimmy, FY, Int. 1)
Sara’s (FY) ideas were less rigid. She spoke of prior knowledge as an information base onto which new learning was added and as a connection to experiences outside of schooling. In the first quote she tends toward a view that sounds very incremental; however, the second quote indicates some understanding of students needing to connect ideas together.

To learn a person must actively be involved in the process in order to construct information in a way that builds upon previous information taught. (Sara, FY, Int. 1)

If a learner cannot make connections with their lives, knowledge will remain abstract, foreign. (Int. 2)

Unlike the novices, the experts spoke of prior knowledge as a bridge to understanding and integrating new information to create better or new explanations. Drawing on students’ prior knowledge provided the way to create connections from one concept or idea to another, or from an informal experience to a scientific concept.

[Prior] understanding of concepts is needed for [understanding] related issues and ideas, creating extensions and applications,… it is like going up Bloom’s taxonomy. (Barbara, E, Int. 2)

They may have general knowledge about a concept but you need to move the general, the detached information without a conceptual base,… The kids need time to tie this together. (Kate, E, Int. 1)

There are some kids who have experience swimming, floating and feeling lighter in water. … They have experienced phenomena that they haven’t been able to explain. (Kate, E, Int. 2)

The experts relied on their students’ prior knowledge being there, but possibly in a disorganized or still experiential fashion that new learning could use to bring ideas together or prompt the students to explain natural events in new ways. The prior knowledge provided a bridge from experience to formal knowledge.

In summary, for the novice teachers prior knowledge tended to be the result of prior teaching and could be defined by what students formally knew about a concept. They saw it having an important role in learning since a teacher would want to be sure that the proper information foundation was in place before new learning could take place. If students had misconceptions, then the teacher could replace the faulty information brick with a new one before going on in their teaching. On the other hand, the expert teachers emphasized the role of students’ ideas and explanations as central to prior knowledge. Therefore, prior knowledge was important in learning because it revealed how students put their ideas together. If the students had misconceptions then you have to get them to think a new way about the concept. Prior knowledge was also important for learning since students needed to extend their understanding or increase their ability to apply the information to a new situation.

How Do Teachers Make Use of Prior Knowledge for Instruction?

It is not unexpected that the most significant difference between the novice and expert teachers was in their knowledge of the students and how they made use of that knowledge in their teaching. However what was unexpected was the novice teachers’ lack of strategies for finding out their students’ prior knowledge. From classroom observations and follow-up discussions it became evident that novice teachers learned about their students’
prior knowledge through unintended classroom interactions. Once aware of a discrepancy between what the students knew and what they expected them to know, the novice teachers were at a loss as to how to change their instructional plans to accommodate the students’ ideas. Sara, a first-year teacher, was observed while her students were working in small groups. As Sara moved from group to group, students repeatedly asked the same two questions about chemical bonds. Sara eventually stopped the class and asked if they have learned this before (Observation notes). Similarly, preservice teacher Angela was observed having her ninth grade biology students categorize animals in an ecosystem as native or introduced. In the discussion following the observation she commented, “I was surprised about how much they didn’t know, and how disorganized they were” (field notes).

The preservice teachers seemed aware that students’ prior knowledge affected their involvement in class, but when asked for cues about how they would know if this was the problem they did not have real guides for what these cues might look like.

If the kids didn’t have questions, um, the kids didn’t act like . . . they don’t know something. I would say it maybe it was too much for them. (Angela, PS, Int. 2)

Researcher: When you say ‘fairly well prepared’ what sort of cues do you have to give you an idea? Ben: Their participation is high. They don’t seem afraid to ask questions. (Ben, PS, Int. 2)

The expert teachers, who at times also found themselves with mismatches between what they expected their students knew and what the students did know saw this as a normal event in teaching and understood the need to modify their instruction based upon the new information they had received.

I realized they really didn’t understand how [weather] fronts work and they didn’t understand convection currents and I thought OK, that’s what I really need to focus in on. I created a different way in which to go over that. . . . And I try and really fine tune in those particular issues. But that is really what teaching is. You know, it’s not a big deal. (Barbara, E, Int. 2)

When the novice teachers did intentionally plan to learn about their students’ prior knowledge the activities were typically not followed up on in the delivery of the new content. They struggled to modify their teaching after eliciting the students’ prior knowledge. Further, they tended to design preassessment activities, which uncovered which facts the students were deficient in, rather than what the students understood or how they explained the concepts. Planning documents submitted by Angela and Sara showed a typical pattern.

Warm-up question on chalkboard: What do you believe ecology to be and include? [Followed by] The students will read from the textbook page . . . and define for themselves what the major components of ecology are. (Angela, PS, Unit plan)

Day 1: KWL about atoms and matter. Day 2: Read sections 1–3 and answer questions in text. (Sara, FY, unit plan)

The plans do not indicate what the teacher will do with the information they gain from the activities. Angela was observed teaching this lesson and had the students check the textbook’s definition of ecology against what they had written, but did not engage the students in discussions about either definition.
First-year teacher Jimmy provided some context for understanding the struggles of novice teachers dealing with students’ prior knowledge.

I usually almost always assess prior knowledge, but planning—it really doesn’t have a whole lot of effect on planning. (Int. 1)

I have given little quizzes beforehand . . . And so I kind of find out [what they know about the new unit]. And probably what should happen, then I should go in and design an activity to build from that prior knowledge. But I want to plan ahead of time, it’s difficult to consider that. (Int. 2)

His comments indicate his awareness that this was something he should be attending to; however, having the information and knowing what to do, or how to use it in planning were different things.

Expert teachers relied heavily on preassessment activities to understand their students’ prior knowledge. They created intentional preassessment activities that allowed them to hear how their students used ideas and concepts to explain events, rather than activities that elicited what the students could recall. They were able to use these activities to target their students’ understanding then modify their instruction based on what they learned. Their knowledge about what to anticipate in their students’ conceptions was instrumental since it allowed them to select appropriate questions.

I have my own conceptions about what the students know then I can pre-test and use that as the start. (Kate, E, Int. 2)

I always have to try and get a sense of what the kids understand about density and what it means . . . [Such as] if I had a box of hot air and a box of cold air was the same size and you could see the molecules. What would you be seeing inside the boxes? And I let the kids kind of draw that out. (Barbara, E, Int. 2)

The expert and novice teachers’ preassessment activities drew out different types of information about their students’ knowledge, which led the teachers to draw different conclusions about their students. Novice teachers used preassessment activities to make students aware of what they did not know, believing this might motivate them to learn new information. As first-year teacher Sara explained in an observation follow-up:

After making a list of what the students know I have the students look at the list to see what they need to know in order to meet the district assessment guidelines. (Sara, field notes)

As compared with the expert teacher Barbara who used preassessment activities to demonstrate to the students how much they already knew, therefore they could certainly master what was coming next.

It’s important to help the kids feel good about what they know already. (Barbara, Int. 2)

Given the novice teachers’ struggles to effectively create opportunities to understand their students’ prior knowledge, they relied on their own childhood experiences to think about what their students might know about a topic. This strategy appeared to be particularly problematic in this urban setting where there were distinct differences in the home-lives of the novice teachers and their students. The novice teachers discussed family trips and
museum visits as examples of how they had learned about science topics and assumed their students would find these examples interesting or familiar.

I used examples of when I went scuba diving and pressure deeper in the water. (Sara, FY, Int. 1)

Well, I watched National Geographic, . . . you know we had a lot of experience outside of the class. My parents took us places and all types of stuff. So I went scuba diving and we did a lot of stuff, things parents and kids do. (Angela, PS, Int. 1)

The examples the preservice teachers selected to create relevance with the science content tended to be exceptional activities, rather than using common examples. These examples were interesting to the students but did not tap into the students’ prior knowledge therefore this strategy reinforced the novices’ belief that prior knowledge was good for engagement. In contrast, the expert teachers rarely referred to non-daily activities when they wanted to connect with their students’ prior knowledge. Kate, an expert teacher, discussed using traffic flow at different times of the day as an example of density or the difference between living in apartment buildings and houses (Int. 2). Barbara asked her students to think about weather reports they see on TV with high and low pressure fronts and how concept of density might explain these events (Int. 2).

The preservice and expert teachers both referred to other authorities as a source of information about students’ prior knowledge. The preservice teachers had read about student misconceptions in their methods class and where aware that there was literature available that could help them with this type of student prior knowledge. The expert teachers both discussed workshops they had attended dealing with student misconceptions and how even lunchtime conversations with colleagues expanded your knowledge about what students do and don’t know or how they interpret information. The first-year teachers reflected that next year they would know a lot more about what to expect about their students’ knowledge, so would make fewer mistakes next year.

It is clear and expected that the novice teachers’ inexperience in classrooms, with curriculum, content, and secondary-age students made understanding and acting on prior knowledge difficult, as Rich and Almonzlin (1999) remarked, “experience is a necessary component of expertise.” However, the novice teachers’ focus on prior knowledge as learned science content and their use of activities that elicited which facts the students knew will continue to limit their understanding of their students’ prior knowledge. The two expert teachers, acted in ways that more closely resemble Akersons, Flick, and Lederman’s (2000) view of prior knowledge. The expert teachers designed activities that had the students explain their prior knowledge then use this knowledge to apply to new situations.

DISCUSSION

There were clear differences in what the preservice, first-year, and expert teachers understood prior knowledge to be and, not unexpectedly, this caused them to act differently in the classroom. The novice teachers in this study held superficial conceptions of knowledge and prior knowledge. They discussed knowledge as if it were a static object, and learning was an accumulation of more bits of information. Therefore when they discussed prior knowledge it was perceived through this limited lens, leading to teaching actions that tried to uncover which bits of knowledge their students had previously learned, which gaps needed filling, then adding on more information.
Novice teachers reinforced their conceptions of prior knowledge and its importance in learning by the strategies they employed to find out about their students’ prior knowledge. Since these activities uncovered factual information rather than explanation, the novice teachers limited their own opportunities to learn about how prior knowledge, as Kelly (1955) theorized, structures thinking. The novice teachers did run into situations when their ideas about what their students should know and what their students did know did not match. These conflicts between expectation and reality could lead the novices to shift their ideas about what prior knowledge is as their own experience base is expanded.

Learning to teach is complex and as part of this learning where attention can be focused needs to be prioritized. The preservice teachers’ attention was focused on the content they needed to teach and what information was needed to “know” the content. The first-year teachers’ attention, in addition to being focused on content, was organized around instruction and what they, the teachers, needed to do to get through the teaching day. These novice teachers, similar to novices in other domains (Berliner, 1994), were limited in their focus and because their own knowledge was poorly organized they interpreted the events in their classrooms in a limited fashion. The two expert teachers, who had the benefit of knowing the content and knowing how to teach, were able to focus on their students. Their thinking about prior knowledge was more complex, including a wider range of meanings and their ability to work with their students’ ideas was flexible allowing them to shift between science content and life experiences. These differences in thinking and action are clearly part of the development of expertise, but they cannot be supplied simply through increased experience.

The expert teachers acted intentionally when they assessed their students’ prior knowledge. Smith (2000) described how her knowledge of her preservice students helps her predict the types of learning problems that will arise and plan to address these problems. Like the expert teachers here, her actions are intentional, not intuitive. These examples help to address the question raised by Peterson and Comeaux (1987), “how does intuition work?” Intuitiveness for the expert teacher is a planned event.

CONCLUSIONS

So what is needed to help preservice teachers to think differently about prior knowledge? This study suggests that preservice science teachers need a more complex view of knowledge as well as of prior knowledge. In order to accomplish this they need opportunities to become aware of the role of their prior knowledge as a lens for their thinking. Pre-service courses need to emphasize and engage students in meta-cognitive activities through which they become aware of how they use their prior knowledge to make decisions about meaning. Similar to students in secondary classrooms, novice teachers need opportunities to articulate and explain educational concepts. These opportunities need to model a wide repertoire of pre-assessment activities to elicit preservice teachers’ prior knowledge and stress the role of explanation and meaning making as knowledge generation.

Although preservice education cannot create all the experiences that time in the classroom provides expert teachers, preservice courses need to intentionally create learning experiences that model learning as sense-making. Furthermore, preservice education programs, particularly those training teachers from the dominant culture to teach in schools serving students from other cultural backgrounds, need to provide opportunities for novice teachers to become acquainted with the worldviews and explanatory methods of the non-dominant culture.

Finally, more research is needed to understand when and why teachers’ views regarding prior knowledge shift and what experiences help teachers move from being experienced
novices to expert teachers. Accounts like Smith’s (2000) of her elementary science methods class are helpful for understanding our own expertise in the field. Detailed accounts of intentional actions taken by expert and novice science teachers will allow us to understand the nature of expertise and its development.

REFERENCES


