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Teaching the Way They Were Taught? Revisiting the Sources of Teaching Knowledge and the Role of Prior Experience in Shaping Faculty Teaching Practices

Amanda Oleson and **Matthew Tadashi Hora**

An oft-repeated mantra in higher education is that faculty[1] "teach the way they were taught," which is largely based on the fact that few faculty receive formal pedagogical training. However, assuming that faculty solely draw on their prior experiences as students may oversimplify the complexity of the processes whereby they actually make teaching-related decisions. While evidence from fields as diverse as psychology, anthropology, and education supports the idea that modeling observed behaviors is an important feature of learning (e.g., Bandura, 1977; Herskovits, 1966), the claim about faculty teaching the way they were taught has little basis in empirical evidence. In fact, research on instructional decision making emphasizes that no single factor determines how teachers plan and teach. Instead, a variety of factors such as different schemata held by individual instructors (e.g., goals, beliefs, and perceptions of constraints and affordances in the environment), the cultural features of institutions and disciplines, and local organizational factors all interact to shape how teachers plan and then teach their courses (Borko, Roberts, & Shavelson, 2008; Henderson & Dancy, 2007; Schoenfeld, 2000; Stark, 2000).

Discerning with more precision the antecedents of faculty instructional decision making is important given that little is known about why faculty "fail to use demonstrably effective teaching methods and other data-based information about teaching" (Menges, 2000, p. 7). Despite substantial and growing efforts to improve undergraduate education, particularly in the science, technology, engineering, and mathematics (STEM) disciplines, the uptake of interactive teaching practices that are based on evidence from the learning sciences is slow and spotty (Fairweather, 2008; President's Council of Advisors on Science and Technology, 2012). While policymakers and researchers point to a variety of explanations (e.g., culture, organizational conditions, faculty resistance) for the apparent maintenance of the status quo (i.e., lecture-based instruction), evidence from research on reform implementation in K–12 schools suggests that investigating teachers' knowledge structures is of critical importance (Spillane, Reiser, & Reimer, 2002). This is because the preexisting cognitive characteristics of teachers act as interpretive lenses through which new policies and instructional innovations are perceived, and ultimately adapted, adopted, or rejected (Coburn, 2001). This line of inquiry is grounded in research from cognitive science and psychology that demonstrates that an individual's knowledge and belief structures, which are largely based on their prior experiences and interactions with the world, exert a considerable influence on cognitive processes such as the perception and encoding of information and problem-solving strategies (Bransford, Brown, &

[1] By *faculty*, we mean all people who hold undergraduate teaching positions—whether full- or part-time, tenured or untenured—in postsecondary institutions. Throughout this paper we use the terms "faculty" and "instructor" interchangeably.

Cocking, 1999; Schank & Abelson, 1977). This has significant implications for educational improvement because, "educational change depends on what teachers do and think—it's as simple and as complex as that" (Fullan, 1991, p. 117).

However, while an extensive body of literature exists on aspects of faculty thinking, such as pedagogical beliefs, approaches, and teaching-related knowledge (Hativa & Goodyear, 2001), little is known about the origins of these cognitive structures. Furthermore, while some researchers acknowledge that the relationship between thought and action is complex and non-linear (e.g., Stark, 2000), others argue that aspects of faculty thinking causally and singularly determine instructional practice (Gibbs & Coffey, 2004; Kember, 1997; Trigwell, Prosser, & Waterhouse, 1999). This deterministic view is also apparent in the "teach the way they were taught" formulation, which identifies instructors' prior experiences as a student as the sole source of pedagogical decision making.

In this paper we argue that this oversimplifies the complexity whereby faculty make decisions about teaching, and overlooks the diverse sources of experiences that shape their instructional knowledge base. Such a view risks alienating faculty as learners by failing to acknowledge the presence of the professional experience accrued throughout their careers, which represents the foundation upon which new pedagogical skills and knowledge must be built (Bransford et al., 1999). Drawing on interviews and classroom observations with 53 faculty from math and science departments in three public research universities, we use thematic and causal network analysis to address the following research questions: (1) What types of prior experiences do faculty perceive as being salient to their teaching? and (2) How, if at all, do these experiences interact with other factors to influence course planning and classroom teaching?

Background

The influence of preexisting knowledge systems in shaping cognitive processing and behavior is widely recognized in cognitive psychology and education research, with much of the seminal research in this area focusing on learning and development. A new piece of information can be assimilated into these preexisting structures if they are well aligned with one another, or they could substantively alter these structures through accommodation (Piaget, 1975). Similarly, based on decades of research in cognitive science and psychology in the learning sciences, people construct new understandings based largely on what they already know (Bransford et al., 1999). Since human cognition is limited in the amount of information that can be perceived at any moment given our perceptual system constraints, various types of inputs (e.g., visual, aural, and haptic) are encoded in a selective fashion that is largely shaped by prior neural associations stored in the brain (Niedenthal, 2007). These preexisting associations will shape perceptions in a variety of ways including which features of a problem to notice and respond to (Bandura, 1977) and organizing information and defining task parameters when engaged in problem-solving (Nisbett & Ross, 1980; Schank & Abelson, 1977).

One of the primary sources of these associations and knowledge structures is direct experience with the world. In particular, it is through observations of other people's behavior that a learner begins to develop a storehouse of knowledge regarding how to perform particular tasks. Bandura's (1977) social learning theory of development emphasizes the important role that the observation of others' behavior plays in this process of shaping an individual's knowledge structures and actions. However, simply observing people does not automatically lead to learned behavior. For the observations to lead to lasting changes in individuals' cognitive structures, they must involve the learner's attention, ability to retain new information and physically reproduce the action, and motivation to model the observed behavior (Bandura, 1977). This view regarding the importance of observation is echoed in research on apprenticeship and the important role that immersion in specific sociocultural environments plays in learning and cognitive development (Cole, 1996; Herskovits, 1966; Lave, 1988, Vygotsky, 1978). As part of the enculturation process, individuals are exposed to both conscious and unconscious conditioning that molds behavior according to the expectations and norms of a particular social group.

These ideas regarding learning and development are particularly salient to education, given evidence that preexisting knowledge systems can inform a variety of instructional behaviors such as the selection of pedagogical techniques, the interpretation of subject matter, and the treatment of particular types of students (Schoenfeld, 2000; Shavelson & Stern, 1981; Foss & Kleinsasser, 1996). The cognitive characteristics of teachers may also influence how new policies and pedagogical innovations are interpreted and responded to (Coburn, 2001; Spillane et al., 2002). Importantly, teachers' knowledge and belief systems are shaped before they begin teaching. Students entering pre-service teacher training programs bring a host of beliefs and assumptions regarding teaching and learning to bear upon their nascent professional practice (Cole & Knowles, 1993; Ball, 1996) which develop into a large body of knowledge and experiences specific to their teaching and discipline once licensed (Shulman, 1987). Lortie (1975) posited that a teacher's body of experience begins to accrue during his or her time as a student, which acts as a preliminary training phase or an "apprenticeship of observation" (Lortie, 1975). However, students likely do not consciously and methodically study and mimic their own instructors; rather they rely on an implicit recall of episodic memories that provide an accessible repertoire of behaviors in the classroom (Nespor, 1987).

Important additional factors shaping teacher knowledge and growth are on-the-job training and experience. Through experimenting with different pedagogical techniques, teachers amass a catalogue of knowledge about what works and what does not work. This type of learning is also known as experiential learning (Bell, 1997; Kolb, 1984), and some characterize the type of practical knowledge as craft knowledge that comes with the "wisdom of practice" (Shulman, 1987). Situated perspectives of experiential learning also emphasize that such learning occurs within the unique constraints and conditions of particular situations (Lave, 1988; Fenwick, 2000).

While a significant body of literature exists that examines facets of faculty growth and development, such as academic socialization (Tierney & Rhoads, 1993), mentoring (Lumpkin, 2011), and participation in professional development (Caffarella & Zinn, 1999), little empirical research exists on how faculty accrue knowledge and experience in their roles as teachers.

However, research on graduate student socialization literature elaborates on the processes whereby faculty knowledge structures are formed. Austin (2002) found that a combination of factors (e.g., interaction with mentors, peers, and friends, collegial feedback, and professional development opportunities) socialized graduate students into the norms and expectations of academic work (see also Tierney & Rhoads, 1993). In one of the few studies on the types of prior experience that shape faculty knowledge about teaching and learning, Hativa (1997) used a survey to evaluate how 115 instructors learned to teach, finding that trial-and-error teaching in the classroom, self-reflection, and student feedback each influenced faculty knowledge and practice. Interestingly, Hativa (1997) found that the observation of professors was not particularly influential in shaping a respondents' understanding about teaching. In spite of this evidence of diverse sources of knowledge that faculty draw upon in their instructional practice, a widely held assumption persists that, because few faculty were provided with formal training in pedagogical methods as part of their graduate training, they mimic the types of instruction they observed as students (Halpern & Hakel, 2003). Also, individual instructors may claim modeling as influential in their practice (e.g., Mazur, 2009). As a result, the phrase "faculty teach the way they were taught" remains an unexamined maxim in higher education research and practice.

We argue that this assumption may have detrimental implications for how initiatives to improve instruction are designed and implemented. If faculty are perceived as teaching solely based on their observations of mentors from undergraduate and graduate training, instructional designers and others engaged in pedagogical reform may overlook instructors' craft knowledge. Indeed, evidence suggests that science faculty perceive educational researchers and those engaged in pedagogical reform as adopting an overly top-down approach to instructional reform where local expertise and practice is ignored in favor of pedagogical "best practices"(Henderson & Dancy, 2008). With a better understanding of how faculty make instructional decisions while drawing upon a variety of knowledge, beliefs, and experiences, educators may be better able to design and implement instructional reforms that are aligned with the actual experiences of faculty, which is an approach that has proven effective in fields including instructional design (Cobb, Zhao, & Dean, 2009), public health (Helman, 1997), and technology adoption (Venkatesh & Bala, 2008). In this paper we build upon this approach to explore the types of prior experiences that inform faculty knowledge about teaching and learning, and how this knowledge is enacted in specific instructional situations.

Methods

The study in this paper is part of a larger research project investigating cultural, cognitive, and contextual factors related to teaching and learning issues in math and science disciplines. For this study we use a qualitative case study design to conduct an in-depth analysis of instructional decision making and practice (Yin, 2008). The case under investigation focuses on 53 math and science instructors at three large, public research universities who taught undergraduate courses in the spring of 2010. In addition, a more in-depth analysis focuses on the instructional decision making of two instructors. We selected the study locations based on their similarities in undergraduate populations and the number of pedagogical reform initiatives in math and science underway at the time of data collection.

The sampling frame for this study included 263 individuals listed in the Spring 2010 timetable as the instructor of record for undergraduate courses in math, physics, chemistry, biology, and geology departments across the three institutions. The course component of interest for this study was the classroom lecture, and not discussion, laboratory, or tutorial sessions. Individuals were contacted up to two times via email and asked to participate in the study, and 137 (52%) faculty responded to these initial contacts. A smaller number of faculty had schedules that allowed for participation in the study and were actually teaching undergraduate courses that semester or quarter, and this paper uses data from 53 participants. The response rates were similar across institutions and disciplines. For more detailed information about the study sample see Table 1.

Table 1: **Description of sample**

	n	Percentage
Sex		
Female	20	38%
Male	33	62%
Discipline		
Math	15	28%
Physics	11	21%
Chemistry	9	17%
Biology	10	19%
Earth/space science	8	15%
Level of course		
Lower division	36	68%
Upper division	17	32%
Size of course		
50 or fewer	10	19%
51–100	16	30%
101–150	8	15%
151 or more	19	36%
Position type		
Lecturer/Instructor (non tenure-track)	26	49%
Assistant Professor	5	9%
Associate Professor	4	8%
Professor	18	34%

We then selected two faculty from this group for in-depth case studies of instructional decision making in practice. Because not all respondents described in detail the relationship among their prior experiences, knowledge about teaching and learning, and their decision-making processes, we selected two individuals who articulated relationships among these factors as they pertained to their own teaching. One individual each was selected on this basis from chemistry and math. Limitations to the study include self-selection bias and the lack of data regarding the tacit or subconscious thoughts of participants, such that an important facet of cognitive activity is necessarily overlooked (Bargh, 2005).

Data Collection

The data collected for this study included interviews and two classroom observations with each respondent. A team of three researchers (i.e., the second author and two graduate assistants) conducted all data collection activities. One researcher observed two class periods of each participant, with interviews taking place immediately prior to or after an observed class.[2]

Interviews. The interviews took approximately 30–45 minutes to conduct. The semi-structured interview protocol consisting of 17 open-ended questions focused on obtaining an account of the decision-making process leading up to the observed class, including key decision points that shaped the curriculum, selection of specific teaching methods, and class content. The key question in the interview salient to this study focused on how or why respondents selected particular techniques for use in their classroom. In response, many respondents cited their prior experience as well as their knowledge base regarding teaching and learning. As a result, we did not specifically ask about the role of prior experiences and/or knowledge in shaping planning and teaching decisions; instead, respondents volunteered this information. In addition, an open-ended introductory question that started the interview ("Can you tell me about the course I'll be observing?"), or what Spradley (1979) called a "grand tour" question, elicited information about the types of factors that shaped their approach to teaching. The instructors were interviewed at their offices or conference rooms, and all interviews were audio recorded and transcribed for further analysis.

Classroom observations. The primary goal of the observations was to describe classroom practices in as detailed manner as possible. As part of a larger study, the Teaching Dimensions Observation Protocol (TDOP) was developed (see Appendix A)[3]. The TDOP used for this study included three categories of codes (i.e., teaching methods, cognitive engagement, and instructional technology), as well as space for detailed notes to be taken regarding the actual content of the class. Importantly, TDOP codes were designed not to correspond to any particular types of knowledge or experiences but to capture nuances of instructional practice.

[2] On a few occasions instructors were not immediately available before or after the class period. In those cases, we conducted the interviews as close to the observations as possible. All interviews were conducted within 2 days of the observations.

[3] The version of the TDOP included in Appendix A has been revised to include new dimensions of practice (e.g., pedagogical strategies such as organizational skills) and new codes for existing dimensions.

The teaching methods category refers to overt and observable pedagogical techniques (e.g., lecturing, small-group work, types of questions posed to students). The cognitive engagement category refers to the types of cognitive activity that students may potentially experience in the classroom. This category is based on research demonstrating that the type and degree of student cognitive engagement in the classroom is a key feature of learning (e.g., Blank, Porter & Smithson, 2001). Finally, the instructional technology dimension refers to instructional materials or technologies used by the instructor. Prior to data collection the three researchers participated in an extensive 3-day training process. During these sessions researchers verbalized their understanding of each code and then deliberated to reach mutual understanding. In order to test this mutual understanding and establish inter-rater reliability, the analysts coded three videoed undergraduate classes (two in chemistry and one in mathematics). The following are the results of the inter-rater reliability using Cohen's Kappa for each pair of raters (averaged across the three categories): Analyst 1/Analyst 2 (.699), Analyst 1/Analyst 3 (.741), Analyst 2/Analyst 3 (.713).[4]

Data Analysis

The data for this study were analyzed in two stages: (1) inductive analysis of all transcripts to identify types of prior experiences, and (2) in-depth case studies of two instructors using the thematic network analysis technique.

Stage 1: Identifying belief types and their dimensionality. All interviews were transcribed and entered into NVivo® qualitative analysis software. The first step in the analysis involved segmenting the data into manageable units (Chi, 1997). Since the transcripts included observations pertaining to many different topics, it was necessary to isolate those fragments of each transcript that pertained to faculty prior experiences and their instructional decision-making. For this phase of the analysis the second author and another analyst independently coded five transcripts using an open-coding process where terms or phrases from the text were used to name a new code. In developing these code lists, they used the constant comparative method, which entailed comparing each successive instance of a newly created code to previous instances in order to confirm or alter the code and its definition (Glaser & Strauss, 1967). The two codes of import for this study were "types of prior experiences" and "factors influencing class planning." After creating the initial code list, which included 10 categories and 135 individual codes, the analysts met to discuss the coding scheme, and then analyzed another five randomly selected transcripts. Then inter-rater reliability was assessed by calculating the percentage of agreement between the analysts in applying the codes (89%). The analysts then applied the coding scheme to all 53 transcripts, which resulted in an extensive NVivo® library of coded text.

Next, the two authors took all text fragments coded as types of prior experiences and analyzed them using the same approach (i.e., constant comparative method), which resulted in the identification of four major categories of prior experiences. During this analysis both authors

[4] See Hora and Ferrare (in press) for detailed information about the development of the TDOP.

met frequently to discuss emerging themes and patterns in the data, thereby leading to a jointly developed set of results.

Stage 2: Case studies of individual instructors. The next stage of the analysis entailed conducting in-depth case studies of two instructors. The analytic technique used in these case studies is based on the thematic network analysis method, which is a structured approach for identifying relationships between concepts or events in a graphic and time-ordered fashion (Miles & Huberman, 1994). Each transcript was analyzed to identify statements in which the respondent explicitly linked some aspect of their knowledge base for teaching and/or their prior experiences, with specific plans for the course that was then subsequently observed using the TDOP instrument. In addition, we identified statements that linked other factors such as instructional goals and perceptions of constraints within the organizational environment with course planning. Finally, we analyzed TDOP data for each instructor and report how many times particular codes were observed as a proportion of all observed codes. Importantly, no causal claims can be made regarding the relationship among prior experiences and knowledge, course plans, and observed teaching practices.

Results

In this section we report the results from this study: types of prior experiences that shaped faculty knowledge about instruction, and case studies of two individual instructors.

Types of Prior Experience

Analysis of the data revealed four types of prior experiences that respondents consciously drew upon when considering their teaching practice. The four main types of prior experiences pertain to the role of the respondent when they acquired the pertinent experience and knowledge. The four types and their subcategories are detailed in Table 2.

As an instructor. Forty-six respondents reported that their experiences as instructors informed their knowledge base for teaching and decision-making processes. These experiences include previous experience in the classroom, professional development, reflection on formal and informal feedback, and interactions with other instructors.

Prior classroom experience. Forty-two respondents reported that their prior experience in the classroom strongly influenced their practice. Some of this instructional experience was gained during graduate school or in post-doctoral positions, which suggests the important influence of early career experiences. For example, one chemistry instructor, describing her strategic use of repetition, said, “I spent a lot of time as a TA before I was a lecturer, and I think that experience kind of gave me the insight that what students really need is to have things shown to them over and over again…” In other instances, longevity in academia translated into either resistance to or acceptance of pedagogical change. One geology instructor claimed he did not seek advice or input about his teaching from others because he had taught for thirty years and had only five or six more years left teaching. In other instances respondents described their practice as evolving, such as the geology instructor who said, “[A]s I assimilate more from that [education research] I may radically change this yet again.”

Table 2. **Description and Frequency of Prior Experience (*N* = 53)**

Type of Prior Experience	Instructor Frequency	Description
Instructor	**46**	Experiences as an instructor
Prior classroom experience	42	Experiences gleaned from prior teaching experiences (e.g. being a TA); trying activities and material and continuing their practice based on outcomes, or observations of students
Professional development	18	Participation in workshops or professional development activities
Feedback	11	Experiences with student feedback and evaluations (formal/informal)
Other instructors	7	Interactions with/observations of peers
Student	**22**	Experiences as a student
How learned	14	Ways instructor learned (or did not learn) as a student
How taught	12	Techniques/topics used to teach instructor while a student
Non-academic roles	**10**	Experiences with family, friends, or activities outside school context
Researcher	**9**	Using information or processes gleaned from research experience

Regardless of the respondents’ stage in their careers, several faculty reported that in-class experimentation or trial-and-error provided a major source of insight into teaching and learning. Trial-and-error applies to both methods of teaching (e.g., trying clickers) and content (e.g., knowing what topics “trip students up” and reacting appropriately). A math instructor described how she came to convey material after a process of trial-and-error: “I found that if I do the traditional way of providing definitions here and proofs there, and then one example—people don’t get it.” As a result, she altered her methods. Respondents also paid attention to particular cues presented by their students and reacted accordingly, such as noticing that students are only writing down what they write or that students remember the “human side” of the material better.

Professional development. Eighteen respondents reported that professional development activities influenced their knowledge base for teaching. These activities included workshops, research groups, individualized feedback (e.g., having their teaching videoed and analyzed), attending seminars, or reading pedagogical research. For example, after attending a two day seminar about student engagement, a biology instructor noted: "that's where I got some of the ideas about having them talk to each other and break up into small groups." Teaching assistant training programs were also influential in forming respondents' knowledge bases. A geology instructor who had her students talk with their neighbor before sharing answers in front of the class noted how her experience in a graduate teaching program gave her the idea for this approach, stating that, "[W]hen I was a graduate student I went to every workshop that they gave." Thus, professional development acts as a key source of instructional knowledge for this group of respondents.

Feedback. Eleven instructors reported that formal and informal feedback of their teaching provided information that directly shaped their instructional decisions. Specifically, student evaluations provide a catalyst for critiquing or validating instructor practices. For example, one math instructor said, "It's very important what [the evaluations] say.… And I adjust depending on what they say." In fact, instructors often cited evaluations from students as the primary way in which to estimate their efficacy as a teacher. A biology instructor who was comfortable with his reviews said that those evaluations, "tell me that I don't really need to drastically alter my style."

Interactions with other instructors. Seven respondents cited the influence of interactions with other instructors in their departments and/or institutions, either through informal conversations or classroom observations that granted them the opportunity to "borrow" perceived good practices. One biology faculty reported, "I think that I am always sifting and winnowing and sampling ideas and techniques [from others]—I'm shameless about borrowing what I think are good ideas." In this way, the social environment provides opportunities for faculty to gain new insights about teaching that can be utilized as part of their own practice.

As a student. Twenty-two respondents reported that their experiences as a student informed their knowledge base for teaching and instructional decisions.

How they learned. Fourteen respondents reported that they had strong memories of how they best learned as students, and that these memories constituted a repertoire of knowledge about teaching that they drew upon in their present roles as instructors. One chemistry instructor said, "I benefited from repetition when I was a student, and so the important concepts from previous lectures I'll always try to repeat." Respondents also remembered their reactions to certain material and drew upon that knowledge when teaching, especially those topics that they found confusing. In some cases, instructors only vaguely recalled memories of their own learning as somehow influencing their teaching, such as a chemistry instructor who said, "I haven't done a whole lot of learning about how people learn, so what I know about is what I learned." This mode of learning then informed how this respondent approached her teaching.

How they were taught. Twelve respondents reflected on the pedagogical techniques that their own teachers used as a primary source of teaching-related knowledge. For example, one physics instructor discussed his experience as a student and its influence on his pedagogy:

> I based most of this on my experience as a student.… [I]f instructors just presented the lecture notes beforehand and read from those I ended up falling asleep. So I tried to create some sort of balance where [the students] have to respond to the clickers and examples in class but they're not spending the entire time just copying.

Another respondent reflected, "I had wonderful teachers who challenged me to be the best that I can be, and so in the same way I challenge my students." These observations are consistent with the "teach they were taught" formulation as they indicate observation and modeling as a key influence on how some faculty teach.

Non-academic roles. Ten respondents reported that non-academic experiences played an important role in shaping their knowledge base for teaching. Instructors frequently cited familial relationships as influential factors. In another case, one respondent noted how using analogies in class came from explaining the material to her niece: "I think [the way I teach] comes from trying to figure out how to explain what I do to a five or ten year old, and her asking me questions like 'What is this thing?'" Two respondents elaborated on how their children generally impacted their views of students, with one chemistry instructor claiming that she knows young people are capable of learning with hard work because her children have excelled in school. Thus, interactions with family can play a considerable role in shaping an instructor's views about teaching and learning. Respondents also reported that involvement in activities outside of academia, such as tutoring high school students or hobbies influenced how they thought about teaching and learning. For example, one math instructor who coached a high school outreach program noted the impact of using flashcards and subsequently created formula notecards for calculus students before exams.

As a researcher. Nine respondents reported that their roles as researchers helped develop their knowledge base about teaching. In some cases, respondents taught students techniques based on how they conduct their own research. For example, a math instructor taught his students how to work out a simpler problem before working out more complex ones. The instructor explained that "I teach the students what works best for me" in regards to mathematical problem solving. In other cases faculty simply bring elements of their research directly into the classroom, such that instruction is viewed in terms of providing a window into the experiences of academic research. As one geology instructor stated, "I think any faculty doing research tries to bring some of that research into the class at no matter what level." I

Case Studies: How prior experiences influence course planning and classroom instruction

Case 1: Dr. Paulson. At the time of data collection, Dr. Paulson[5] was a full professor teaching a lower division advanced general chemistry course at a large, public research university. In response to the question about the factors that shape how he planned and taught his course, Dr. Paulson reported a variety of prior experiences that influenced this process.

Dr. Paulson stated that his experiences as an instructor have provided him with a wealth of knowledge about effective instruction. With more than 40 years of experience in the classroom, he felt that he has discovered which teaching methods effectively engage students and keep their attention in the classroom. This emphasis on maintaining student's attention is grounded in the belief that learning requires sustained attention and hard work. As he stated, "I find if I keep them interested, they'll learn, [but] if they get bored, they are not going to learn anything." Through his time in the classroom, Dr. Paulson has found that particular teaching techniques are more effective than others in fostering student engagement, such that these prior experiences directly inform his current approach to teaching. For example, he uses the periodic table frequently to help students get "hooks" into the content and to improve retention. In addition, he has found that student attention can be obtained through the use of visual aids such as movies and demonstrations, which are effective because they bring abstract principles of chemistry into a more tangible and accessible form. Each of these perspectives on instruction is grounded in Dr. Paulson's decades of experience in the classroom.

However, his approach to teaching the observed class was not solely informed by these experiences. Dr. Paulson also drew upon his experiences in research in conveying real world examples, which he felt was invaluable to his students because, "by using examples that fit the real world [students] will remember it better than if you just give them a random piece of information." Thus, the instructional goal of engaging students, which is grounded in his years of experience as an instructor, directs Dr. Paulson to tap into the large repertoire of knowledge he has accrued in his capacity as a research scientist. Further, his experience outside of academia, particularly that of an injury that had detrimental impact on his motor skills. As he explained, "I am very shaky and do not have good muscle control, and that is why I went to PowerPoint." Thus, a combination of experiences as an instructor, researcher, and from outside of academia influenced his teaching. Importantly, contextual factors such as a highly structured curriculum that afforded little autonomy in terms of selecting content also influenced this process.

In Dr. Paulson's two observed classes, he planned to discuss chemical bonding and electron orbitals. Dr. Paulson lectured for 90% of the observed 5-minute intervals[6] and used the overhead projector with transparencies for 90% of the observed intervals. He used those two modes to convey information, along with using slides on his laptop for 25% of the observed intervals. Additional teaching methods used included demonstrations (25%) and illustrations (10%).There was no cognitive engagement for students to connect information to the real world

[5] All names used in the case studies are pseudonyms.

[6] For each 50-minute class period a total of 10 intervals were observed.

observed, rather they were mostly expected to receive and memorize information (100%). Dr. Paulson's prior experiences in the classroom that led him to believe that engaging his students is a critical factor in effective teaching can be associated with his use of demonstrations and illustrations. Regardless of his stated goal of actively engaging students, lecturing was still the dominant mode of instruction, which suggests that more tacit views of teaching and/or habituated practices may guide Dr. Paulson's teaching more than his self-reported decision making steps articulated in this interview.

Case 2: Dr. Christensen. At the time of data collection, Dr. Christensen was a lecturer teaching an upper level matrix algebra class that was part of a math sequence at a large, public research institution. While discussing her teaching practice, Dr. Christensen referenced her experiences as an instructor, as a researcher, and as a student.

Like Dr. Paulson, Dr. Christensen attributed part of her current teaching practice as an outcome of her prior experiences in the classroom as an instructor. Having last taught the class 15 years ago, she described how her teaching strategies "developed" with time. Although Dr. Christensen received teacher training when she first began teaching, she found the training unsuitable for her particular style and instead "just did what felt comfortable to me, which was working examples—getting the students involved … trying to get them to come up and work at the blackboard." This "structured discussion" strategy evolved over time. More specifically, Dr. Christensen remembered students' difficulty with vector space when she last taught the class and therefore tried to emphasize it in her current class. She explained, "I remember [vector space] was the most difficult thing. So every time I come upon an example of a vector space, I try to say something about it." Dr. Christensen's teaching has also been affected by evaluations, which indicated some ineffective mannerisms such as talking while writing on the blackboard or not looking at the students.

Besides her experience as an instructor, Dr. Christensen's involvement in research influenced her teaching both in terms of content and teaching strategies. When discussing content related to her area of research, she found herself wanting to explain the "beauty" of mathematical theory to inspire her students and "spark their imagination." However, a fixed syllabus and subsequent constraints on time prevented her from delving very deeply into issues she saw as important.

Finally, Dr. Christensen attributed her experiences as a student as significant in her current teaching. She mentioned that she "probably picked up [techniques] from teachers I admired," but explained that teaching comes "naturally" to her. However, she stated that when she took classes that taught material from abstract to specific it did not make sense to her. She recalled, "[I]t doesn't seem like the most natural way to learn to me personally." Subsequently, she taught from the specific case to the abstract, and she likewise recounted encouraging a novice instructor to do the same for his students.

During the observed class, Dr. Christensen primarily worked through problems (70% of the 20 5-minute observed intervals) at the chalkboard, while occasionally pausing to elaborate on key points. In terms of instructional technology, she used the blackboard in almost every interval (95%), and students were usually expected to receive and memorize information (85%) and rarely expected to problem solve (5%). While asking her students a mix of comprehension, rhetorical, and questions seeking a response (40%), students asked many questions too, and Dr. Christensen spent time discussing geometric dimensions (a topic that students were struggling to understand). Based on her stated preference for working out problems at the board, and subsequent observations that confirmed this teaching approach, it appears that Dr. Christensen's experience as an instructor in the classroom and her preference for board-work informed her practice. Additionally, it is possible that Dr. Christensen's experiences as a student guided her method of explaining particular rules and in working from specific problems to general rules.

Discussion

In this paper we presented evidence regarding the types of prior experience that faculty report as playing a key role in shaping their knowledge base for teaching and learning. In a closer investigation of how two faculty draw upon their prior experiences when planning and teaching a specific class, we demonstrated that faculty draw upon a variety of these experiences when planning and teaching their classes. In this section we discuss key findings from the study and implications for instructional improvement in undergraduate education.

Faculty Teaching Is Shaped by a Variety of Prior Experiences

This study was largely motivated by the desire to examine whether or not the oft-cited that "faculty teach the way they were taught"—that is, through imitating and modeling the practices of their mentors—was in fact borne out by evidence from an empirical study of faculty decision making. The evidence shows that faculty decisions about course planning and classroom instruction is more complex than this formulation suggests, and that modeling and imitation of one's own teachers is not the dominant or only type of prior experience that shapes faculty teaching. Instead, our analysis of interview transcripts revealed four types of experiences that inform faculty knowledge about teaching and learning: experience as an instructor, as a student or learner, as a person outside of their academic roles, and as researchers. Based on this evidence, we argue that viewing faculty teaching as solely informed by knowledge shaped through modeling and imitation oversimplifies the complexity whereby faculty make decisions about teaching, and overlooks the diverse sources of experiences that shape their instructional knowledge base. We highlight three of these experience types for further discussion. .

Prior experience in the classroom. The data reported in this paper indicate that time spent in the classroom as an instructor is an influential source of knowledge about teaching and learning. This type of knowledge is also known as craft knowledge, practical knowledge, or knowledge gleaned from wisdom of practice (Shulman, 1987). The evidence from our study supports prior research that highlighted the role that experiential learning played in the professional growth of K–12 teachers (Smylie, 1989), as well as postsecondary faculty (Hativa, 1997). This process of experiential learning allows knowledge to be "continuously derived from and tested out in the experiences of the learner" (Kolb, 1984, p. 27). As one respondent stated, her approach to teaching was based on "on-the-job experience of what I think students would learn and how students will learn [the material] best." In some cases, instructors relied on experiences in the classroom as part of an ongoing process of pedagogical change, such that new insights would be applied to preparations for the next class or course. Thus, the data reveal that instead of blindly mimicking their past instructors, some faculty utilize an evolutionary approach to course planning that is based on classroom experience, constant experimentation, and self-reflection.

Of course, extensive experience in the classroom does not always lead to such an approach of continual improvement. For some instructors, once established in their instructional habits they may be less apt to alter or change their teaching approach. For example, Dr. Christensen stated that she was "set in her ways" and "suspicious" of educators, especially those who had never taught math but who promised "cookie cutter solutions" to instructional reform. The stabilization of an instructor's knowledge base and subsequent teaching practice is supported by research indicating that changes to individuals' belief systems and/or behaviors are difficult in adulthood (Pajares, 1992). As individuals accumulate experiences and deeply held beliefs about appropriate and effective behavior, any alterations to this repertoire of problem-solving strategies will need to be viewed as pertinent to the individual's current work, convincing, and aligned with the existing constraints and conditions of their workplace (Bransford et al.,, 1999; Merriam, Caffarella, & Baumgartner, 2007). This suggests that for those faculty who see no need for altering or improving their teaching practice, educators will need to demonstrate why new techniques or approaches are worth trying and how they can be adapted to fit the particular needs of the instructor.

A closer look at imitation and modeling. Another important source of knowledge that faculty draw upon when planning and teaching their courses is based on their experiences as students. This point is exemplified by the observations of a math instructor, who stated that "[teachers] learn by observing other teachers—we learn by osmosis, and by just observing other people and picking up what we like and what we don't like." That is, the role of imitation and modeling that is suggested by the phrase "faculty teach the way they were taught" is substantiated by the data reported in this paper, but, again, only as one of four different types of experiences that shape faculty knowledge.

Interestingly, the data also indicate that, in recalling previous experiences as students that are influential to their current practice, faculty vary in the degree of specificity with which they reported the influence of modeling and observation. Most of the time, vague recollections were associated with how the instructor was taught, while more specific instances pertained to how they best learned. For instance, Dr. Christensen could not directly cite how her experience as a student translated into her lesson planning or actual behavior—she just said she had probably picked up some techniques from her previous teachers without specifying which ones were being imitated. Given limitations in the cognitive capacity for storing specific episodes in memory that results in the "chunking" of specific instances into larger units, the reduction of multiple exposures to a mentor's teaching into an ambiguous recollection of that mentor's teaching is not unexpected (Gobet & Simon, 1998; Miller, 1956). Thus, faculty may aggregate their own previous experiences as students into a gestalt of episodes that constitute a vague yet important type of knowledge about teaching and learning.

Yet, faculty also recalled specific techniques pertaining to how they best learned or did not learn, and then referenced these episodes as examples of how they elected to teach or not teach in their current roles. For example, Dr. Christensen did not teach abstract to specific because it did not make sense to her, although that was how she was taught. Thus, instructors may not necessarily base their specific teaching practices one examples from their own teachers (Lortie, 1975), but rather focus on how they best learned as students or what felt right to them.

Finally, imitation and modeling should not be viewed solely in terms of an individual's prior experiences as a student, but should also encompass the sociocultural milieu of the instructor's current workplace. As faculty grow and develop they may emulate peers whom they consider to be exemplary instructors, and will also be influenced by their colleagues through a variety of means including shared curricula, hallway conversations, and formal professional development initiatives. The fact that learning through imitation and modeling is a strongly cultural process is well established in the literature (Bandura, 1977; Lave, 1988; Vygotsky, 1978), and the growth and maturation of faculty should take into account this important source of professional knowledge.

Influences from non-academic sources. Experiences outside of the academy are largely understudied in the literature, but still represent an important aspect of faculty's knowledge bases of teaching according to these data. Hativa (1997) found that contexts outside of the university, such as tutoring, were an influential component in instructors learning how to teach. Our data reveal similar instances of external activities that further develop an instructor's repertoire of teaching practices.

While these data elaborate on activities outside of the academy, they also detail the role of the family in shaping faculty behavior in the classroom. In several cases, respondents discussed teaching with spouses who were also teachers, instructors, or researchers. Being a parent may also influence how instructors approach their students. Thus, there are many influences on faculty teaching practice that do not originate from their academic roles—rather they are based on the day-to-day experiences of faculty

The Complexities of Instructional Decision Making

It is well established in the literature on K–12 teacher cognition that no single factor can adequately explain why a teacher makes the decisions that he or she does. A complex combination of cognitive (e.g., beliefs, decision heuristics, knowledge types), sociocultural, and organizational factors interact in particular situations to influence teaching behaviors (Borko et al.,, 2008; Shavelson & Stern, 1981). In particular, the important role of individual perception and sense-making is evident in the process whereby teachers perceive their institution, department, or classroom as providing certain constraints or affordances to their work, which in turn affects how they plan their classes, interact with students, and select instructional strategies (Greeno, 1998; Lee & Porter, 1990). Consequently, arguments that faculty teaching can be explained solely by a single construct such as "approaches to teaching" (e.g., Trigwell et al., 1999) or faculty sub-culture (Umbach, 2007) obfuscates the complexity and dynamism of the instructional decision-making process. This oversimplification is also evident in the notion that faculty "teach the way they were taught." Instead, the case studies presented in this paper demonstrate how other factors, including various types of prior experience, perceived affordances in the environment, and beliefs about learning, influenced how Drs. Christensen and Paulson planned their classes. The data presented in this and other papers (see also Hora & Ferrare, in press) represent an initial attempt at articulating the specific mechanisms that constitute the planning process and the factors that impinge upon instructional decision making along the way. While only the broad outlines of these processes are beginning to be understood, it is clear that simplistic and deterministic accounts of faculty practice are unsupported by the empirical literature.

Implications and Conclusion

These results have implications for the work of policymakers and instructional designers engaged in pedagogical improvement and faculty development. One of the dominant approaches to improving teaching at the postsecondary level is to expose faculty to bodies of literature with which they likely have had little prior experience—that of cognitive psychology and educational research (Halpern & Hakel, 2003; Saroyan & Amundsen, 2004). One of the basic principles of the learning sciences is that learners come into any instructional situation with preconceptions about a topic (e.g., the best way to teach undergraduates about climate change) that must be elicited and engaged so that learners can effectively comprehend new information (Bransford et al.,, 1999). Based on this principle of learning, Halpern and Hakel (2003) argue that faculty should "assess learner knowledge and understanding at the start of every instructional encounter, probing for often-unstated underlying assumptions and beliefs that may influence the knowledge, skills, and abilities that we want students to acquire" (p. 39).

This principle also applies to adult learners, which suggests that faculty developers should adopt a similar approach to the faculty who come to their workshops, brown bag talks, and seminars. Yet in making the assumption that faculty have little to no prior knowledge about teaching and learning, and that their knowledge base is composed exclusively of how they were taught, educators ignore this fundamental idea about learning. Instead, the existing skill sets, craft knowledge, and instructional challenges facing faculty in specific situations (e.g., creating a new syllabus for Geology 210) should be the foundation upon which professional development activities are built (Putnam & Borko, 2000).

Further, the varied experiences and knowledge bases that inform faculty practice also represent the lens through which faculty will interpret new information. Evidence suggests that teachers in the K-12 sector will interpret new policies or innovations and make decisions about whether to adopt, adapt, or reject them, largely based on their preexisting knowledge structures and routinized practices within particular school settings (Spillane et al., 2002). Given evidence that some faculty perceive educational researchers as adopting an overly dogmatic stance that blames faculty as the primary cause of poor student outcomes, and that teaching innovations are designed with little input from faculty (Henderson & Dancy, 2008), instructional designers would benefit from assessing local teaching conditions and practices prior to crafting professional development activities (Cobb et al., 2009). This is especially true for faculty who do not see a need to change their teaching. New reforms should carefully consider the context of instruction, as well as showing the pedagogical usefulness of the initiative. In the quest to improve undergraduate education the prior experiences and professional knowledge of faculty should not be denigrated or ignored. Instead, these experiences and types of knowledge warrant careful examination.

Several directions for future research on the role of faculty knowledge in shaping instructional decisions are suggested by the data reported in this paper. Investigations of the relationship between specific types of knowledge (e.g., procedural knowledge) and the selection of specific types of instructional strategies (e.g., use of small group work) could be conducted in controlled experimental settings. Coupled with more naturalistic analyses of instructional decision making (e.g., Schoenfeld, 2000), such experimental studies would allow for more focused investigation of the role of knowledge types in shaping faculty teaching practice. In addition, articulating precisely how faculty experiences as learners, instructors, researchers, and as non-academics inform specific types of knowledge could also be a productive line of inquiry. Finally, the recognition that much of cognitive activity operates on an automatic or subconscious level suggests that research on faculty work should begin to account for the influence of tacit knowledge (e.g., Bargh, 2005). As the field of higher education gains more insights into the origins of faculty knowledge and how this knowledge is deployed in practice, faculty will hopefully be viewed as professionals who would benefit from formal training in the learning sciences and whose knowledge about teaching and learning represents a rich body of experience that can be fruitfully built upon.

Reference List

Austin, A. E. (2002). Preparing the next generation of faculty: Graduate school as socialization to the academic career. *The Journal of Higher Education, 73*(1), 94–122.

Ball, D. L. (1996). Teacher learning and the mathematics reforms: What we think we know and what we need to learn. *Phi Delta Kappan, 77*(7), 500–508.

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Bargh, J. A. (2005). Bypassing the will: Toward demystifying the nonconscious control of social behavior. In R. R. Hassin, J. S. Uleman, & J. A. Bargh (Eds.), *The new unconscious: Oxford series in social cognition and social neuroscience* (pp. 37–58). Oxford, England: Oxford University Press.

Bell, M. (1997). The development of expertise. *Journal of Professional Development*, *68*(2), 34–38.

Blank, R. K., Porter, A., & Smithson, J. (2001). *New tools for analyzing teaching, curriculum and standards in mathematics and science. Results from Survey of Enacted Curriculum Project*. Final Report to the National Science Foundation on Contract No. REC98-03080. Washington, DC: Council of Chief State School Officers.

Borko, H., Roberts, S. A., & Shavelson, R. (2008). Teachers' decision making: From Alan J. Bishop to today. In P. Clarkson & N. Presmeg (Eds.), *Critical Issues in Mathematics Education: Major Contributions of Alan Bishop* (pp. 37–67). Netherlands: Springer.

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

Caffarella, R. S., & Zinn, L. F. (1999). Professional development for faculty: A conceptual framework of barriers and supports. *Innovative Higher Education, 23*(4), 241–254.

Chi, M. T. H. (1997). Quantifying qualitative analyses of verbal data: A practical guide. *The Journal of the Learning Sciences, 6*(3), 271–315.

Cobb, P., Zhao, Q., & Dean, C. (2009). Conducting design experiments to support teachers' learning: A reflection from the field. *Journal of the Learning Sciences, 18*(2), 165–199.

Coburn, C. (2001). Collective sensemaking about reading: How teachers mediate reading policy in their professional communities. *Educational Evaluation and Policy Analysis, 23*(2), 145–70.

Cole, A. L., & Knowles, J. G. (1993). Shattered images: Understanding expectations and realities of field experiences. *Teaching & Teacher Education*, *9*(5/6), 457–471.

Fairweather, J. (2008). Linking evidence and promising practices in science, technology, engineering, and mathematics (STEM) undergraduate education: A status report for the

National Academies Research Council Board of Science Education. Retrieved from http://www7.nationalacademies.org/bose/Promising%20Practices_Homepage.html

Fenwick, T. J. (2000). Expanding conceptions of experiential learning: A review of the five contemporary perspectives on cognition. *Adult Education Quarterly, 50*, 243–272.

Foss, D. H., & Kleinsasser, R. C. (1996). Preservice elementary teachers' views of pedagogical and mathematical content knowledge. *Teaching & Teacher Education, 12*(4), 429–442.

Fullan, M. (1991). *The new meaning of educational change.* Toronto, Canada: O.I.S.E. Press.

Gibbs, G., & Coffey, M. (2004). The impact of training of university teachers on their teaching skills, their approach to teaching, and the approach to learning of their students. *Active Learning in Higher Education, 5*(1), 87–100.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. New Brunswick, NJ: Aldine Transaction.

Gobet, F., & Simon, H. A. (1998). Expert chess memory: Revisiting the chunking hypothesis. *Memory, 6*(3), 225–255.

Greeno, J. G. (1998). The situativity of knowing, learning, and research. *American Psychologist, 53*(1), 5–26.

Halpern, D. F., & Hakel, M. D. (2003). To the university and beyond: Teaching for long-term retention and transfer. *Change, 35*(4), 36–41.

Hativa, N. (1997, March). Teaching in a research university: Professors' conceptions, practices, and disciplinary differences. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Hativa, N., & Goodyear, P. (Eds.). (2001). *Teacher thinking, beliefs, and knowledge in higher education*. Norwell, MA: Kluwer Academic Publishers.

Helman, C. G. (1997). *Culture, health and illness* (1st ed.). London, England: Hodder Arnold.

Henderson, C., & Dancy, M. H. (2008). Physics faculty and educational researchers: Divergent expectations as barriers to the diffusion of innovations. *American Journal of Physics, 76*(1), 79–91.

Herskovits, M. J. (1966). *Cultural anthropology*. New York, NY: Alfred A. Knopf, Inc.

Hora, M. T., & Ferrare, J. (in press). Instructional systems of practice: A multidimensional analysis of math and science undergraduate course planning and classroom teaching. *The Journal of the Learning Sciences*.

Kember, D. (1997). A reconceptualisation of the research into university academics' conceptions of teaching. *Learning and Instruction, 7*, 255–275.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Lave, J. (1988). Cognition in practice: Mind, mathematics and culture in everyday life. Cambridge, UK: Cambridge University Press.

Lee, O., & Porter, A. (1990). Bounded rationality in classroom teaching. *Educational Psychologist*, *25*(2), 159–171.

Lortie, D. C. (1975). *Schoolteacher: A sociological study*. Chicago, IL: University of Chicago Press.

Lumpkin, A. (2011). A model for mentoring university faculty. *The Educational Forum*, *75*, 357–368.

Mazur, E. (2009). Farewell, lecture? *Science, 323*, 50–51.

Menges, R. (2000). Shortcomings of research on evaluating and improving teaching in higher education. *New Directions for Teaching and Learning*, *83*, 5–11.

Merriam, S. B., Caffarella, R. S., & Baumgartner, L. M. (2007). *Learning in adulthood: A comprehensive guide* (3rd Ed.). Hoboken, NJ: John Wiley & Sons Inc.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis (2nd ed.)*. Thousand Oaks, CA: Sage Publications. National Research Council, 2000.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63*(2), 81–97.

Niedenthal, P. M. (2007). Embodying emotion. *Science, 316*, 1002–1005.

Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies, 19*(4), 317–328.

Nisbett, R., & Ross, L. (1980). *Human inference: Strategies and shortcomings of social judgment.* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62*, 307–332.

Piaget, J. (1975). *The development of thought: Equilibrium of cognitive structures*. New York, NY: The Viking Press.

President's Council of Advisors on Science and Technology (2012). *Report to the President. Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering and mathematics*. Executive Office of the President. Washington, DC.

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.

Saroyan, A., & Amundsen, C. (2004). *Rethinking teaching in higher education: From a course design workshop to a faculty development framework*. Sterling, VA: Stylus Publishing.

Schank, R. C., & Abelson, R. P. (1977). Scripts, plans, goals, and understanding. Hillsdale, NJ: Erlbaum.

Schoenfeld, A. H. (2000). Models of the teaching process. *Journal of Mathematical Behavior, 18*(3), 243–261.

Shavelson, R. J., & Stern, P. (1981). Research on teachers' pedagogical thoughts, judgments, decisions, and behavior. *Review of Educational Research, 51*(4), 455–498.

Shulman, L. (1987) Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1–21.

Smylie, M. A. (1989). Teachers' views of the effectiveness of sources of learning to teach. *The Elementary School Journal*, *89*(5), 543–558.

Spillane, J. P., Reiser, B. J., & Reimer, T. (2002). Policy implementation and cognition: Reframing and refocusing implementation research. *Review of Educational Research, 72*(3), 387–431.

Spradley, J. P. (1979). *The ethnographic interview*. New York, NY: Harcourt, Brace, Janovich.

Stark, J. (2000). Planning introductory college courses: Content, context and form. *Instructional Science, 28*, 413–438.

Tierney, W. G., & Rhoads, R. A. (1993). *Enhancing promotion, tenure and beyond: Faculty socialization as a cultural process.* Washington, DC: Association for the Study of Higher Education.

Trigwell, K., Prosser, M., & Waterhouse, F. (1999). Relations between teachers' approaches to teaching and students' approaches to learning. *Higher Education, 37*, 57–70.

Umbach, P. (2007). Faculty cultures and college teaching. In R. P. Perry & J. C. Smart (Eds.), *The Scholarship of Teaching and Learning in Higher Education: An Evidence-Based Perspective* (pp. 263–317). Netherlands: Springer.

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, *39*(2), 273–315.

Vygotsky, L. S. (1978). Mind in society: Development of higher psychological processes. In M. Cole, V. John-Steiner, S. Scribner, & E. Souberman (Eds.). Cambridge, MA: Harvard University Press.

Yin, R. (2008). *Case study research: Design and methods*. (4th ed.). Thousand Oaks, CA: Sage Publications, Inc.

Appendix A: Teaching Dimensions Observation Protocol (TDOP)

Minutes	0-4	5-9	10-14	15-19	20-24	25-29
Teaching Methods	LEC IL DEM SGW MM CS PS OT B RQ DCQ DAQ CQ NQ CL CD DW	LEC IL DEM SGW MM CS PS OT B RQ DCQ DAQ CQ NQ CL CD DW	LEC IL DEM SGW MM CS PS OT B RQ DCQ DAQ CQ NQ CL CD DW	LEC IL DEM SGW MM CS PS OT B RQ DCQ DAQ CQ NQ CL CD DW	LEC IL DEM SGW MM CS PS OT B RQ DCQ DAQ CQ NQ CL CD DW	LEC IL DEM SGW MM CS PS OT B RQ DCQ DAQ CQ NQ CL CD DW
Notes: Include brief description of what the instructor is actually doing here (e.g., content being discussed, sequence of argumentation, etc.)						
Cognitive Engagement	RM PS CR IN CN	RM PS CR IN CN	RM PS CR IN CN	RM PS CR IN CN	RM PS CR IN CN	RM PS CR IN CN
Notes						
Instruct. Technology	PO BB LC CL B OP D OB P T	PO BB LC CL B OP D OB P T	PO BB LC CL B OP D OB P T	PO BB LC CL B OP D OB P T	PO BB LC CL B OP D OB P T	PO BB LC CL B OP D OB P T
Notes						