Exploring Faculty Beliefs about Student Learning and Their Role in Instructional Decision-Making

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Abstract
This study utilizes theory from situated cognition to investigate faculty beliefs about student learning and their influence on teaching decisions. Results of interviews with and observations of 56 science and math faculty found that the two most common beliefs are: (a) students learn best through repeated practice, and (b) students have different learning styles. The remaining 13 beliefs exhibited an underlying dimensionality regarding whether teachers or students are responsible for constructing knowledge and understanding. These findings provide insights into factors that can be used to design locally attuned interventions in contrast to a “top-down” model of change.
Exploring Faculty Beliefs about Student Learning and Their Role in Instructional Decision-Making

Matthew T. Hora

A long-standing problem in education is to identify the determinants of a teacher’s instructional practice, based on the idea that such insights could be used to improve the quality of teaching and student learning. While researchers of both K-12 and postsecondary teaching focus on a multitude of factors that influence teaching, such as institutional contexts, disciplinary affiliation, and appointment types, the role of teacher thinking or cognition has remained a substantial area of interest since the 1980s. As Fullan (2001) stated, “Educational change depends on what teachers do and think—it’s as simple and as complex as that” (p. 115). In particular, an extensive literature exists on teachers’ beliefs about how students learn. This focus is grounded in evidence from cognitive psychology that beliefs play an influential role in
problem-solving by filtering new information, framing problems, and guiding action in concert with other mental representations such as goals (Fives & Buehl, 2012; Nespor, 1985). Importantly, beliefs and other cognitive schemata do not unilaterally dictate behavior as features of the task environment also shape how individuals perceive and solve problems (Greeno, 1988).

Extensive research at the postsecondary level has similarly examined how the pedagogical thoughts of faculty influence their teaching, using a variety of constructs such as approaches to teaching (Prosser, Trigwell, & Taylor, 1996) and beliefs about teaching and learning (Samuelowicz & Bain, 1992, 2001). In general, this literature advances two propositions regarding the nature of faculty thinking and its relationship to teaching. First, researchers suggest that the pedagogical thoughts of postsecondary teachers can be characterized as exhibiting an underlying dimensionality that exists on a continuum from student-centered to teaching-centered orientations (Kember, 1997). Second, researchers suggest that a causal relationship exists between these beliefs, specific types of teaching practices, and student learning, and that efforts to improve educational outcomes should support faculty in obtaining the more sophisticated student-centered perspectives (Gibbs & Coffey, 2004; Ho, Watkins, & Kelly, 2001).

However, this body of literature is limited by a lack of evidence regarding the precise nature and content of the beliefs themselves, and how they operate in specific contexts to inform (or not) actual teaching decisions and behaviors (Eley, 2006; Kane, Sandretto, & Heath, 2002). A promising line of inquiry addresses these limitations by drawing upon situated cognition theory to explore faculty thinking and decision-making as it unfolds in specific organizational contexts and teaching situations (Lattuca, 2005; McAlpine, Weston, Timmermans, Berthiaume, & Fairbank-Roch, 2006; Hora, 2012). In this article, I elaborate on this body of research by using the situative perspective of Greeno (1998), which emphasizes how behavior is largely shaped by an individual’s perception of the constraints and affordances related to a specific problem or task situation, which then suggests a delimited range of options for action.

The article addresses the following questions:

- What beliefs do faculty have for how undergraduate students learn in their discipline?
- What, if any, underlying dimensionality exists for these beliefs?
- How, if at all, do beliefs interact with other factors to influence how faculty plan and teach their classes?

In exploring these phenomena among a sample of 58 math and science faculty in public research universities, I make the case that, while postsecondary teachers can be characterized as having beliefs that either emphasize the student or teacher as the primary constructor of knowledge, they cannot accurately be characterized as having a single “type” of belief and that a direct
correspondence between beliefs and practice should not be assumed. This is due to the fact that decisions about matters including curriculum planning and classroom activities are shaped by a complex array of factors that include combinations of instructors’ cognitive characteristics (e.g., beliefs, prior experience) and such situational elements as disciplinary affiliation and the local institutional context. With information about which aspects of faculty thinking and contextual factors seem to exert outsized influences on local instructional decision-making, it becomes possible to design interventions or professional development programs that are closely aligned with existing practice rather than imposing externally derived policy or programs in a top-down manner (Spillane, Halverson, & Diamond, 2001).

**Background**

An extensive literature exists on the various factors that shape postsecondary instruction that include disciplinary affiliation (Becher & Trowler, 2001), administrative policies (Fairweather & Rhoads, 1995), faculty culture (Austin, 1990), and appointment types (Umbach, 2007b), to name but a few. (For a review, see Menges & Austin, 2001.) Given that faculty are influenced by a complex web of these and other factors in their daily work, research that accounts for a variety of influences on faculty decision-making more closely resembles real-world situations than single-variable studies may suggest. As Umbach (2007a) argues, research focusing on singular explanations of teaching behavior “assumes a simplicity and linearity of attitudes and behavior that may not exist in complex organizations” (p. 286).

Thus, research that acknowledges the non-linearity and complexity of academic work, while also accounting for individual agency and the role of organizational and socio-cultural contexts, is necessary to advance the field of higher education’s understanding of educational practice in real-world settings. Examples of such an integrative approach include research on faculty growth and development (O’Meara, Terosky, & Neumann, 2008), curriculum design (Hora & Ferrare, 2013), and interdisciplinary work (Lattuca, 2005). What these investigations foreground is the primacy of individual agency and the ability of educators to recognize situations and make decisions accordingly, in ways that are more or less constrained by the environment. It is the formidable role that an individual’s cognitive characteristics play in academic work that inspired decades of research on faculty cognition in general and pedagogical beliefs in particular, a literature to which I now turn.

**Research on Faculty Beliefs**

A substantial amount of research exists on faculty thinking (reviewed in Hativa & Goodyear, 2001), with a distinct line of inquiry focused on the role of pedagogical beliefs and their related “approaches to teaching” that began in
the early 1990s and continues to the present time. One of the earliest studies on this topic was a 1996 analysis of faculty beliefs about how students learn, in which Prosser, Trigwell, and Taylor interviewed 24 chemistry and physics faculty. They found that faculty had five conceptions of learning: (a) learning as accumulating more information to satisfy external demands, (b) learning as acquiring concepts to satisfy external demands, (c) learning as acquiring concepts to satisfy internal demands, (d) learning as conceptual development to satisfy internal demands, and (e) learning as conceptual change to satisfy internal demands. The authors also argued that these beliefs exist as a hierarchy such that conception (e) encompasses all other conceptions, and that conception (e) is the most pedagogically sophisticated of all conception types. The characteristics underlying these beliefs served as the conceptual basis for the development of the “approaches” to their teaching research program, which posits that teaching approaches vary from teacher-centered, where instructors view teaching as the delivery of content, to student-centered, where instructors view teaching as the active facilitation of student learning (Trigwell, Prosser, & Taylor, 1994).

The notion that faculty thinking varies along a student- and teacher-centered dimension is widely shared in the literature (Kember 1997; Samuelowicz & Bain, 1992). Some view these dimensions as mutually exclusive points on a single continuum, such that individual faculty can be identified as holding a particular approach (Trigwell & Prosser, 2004). Further, some argue that a direct relationship exists between these approaches and aspects of teaching and learning. For example, Kember (1997) states that “a lecturer who holds an information transmission conception is likely to rely almost exclusively on a unidirectional lecture approach” (p. 270) and Trigwell, Prosser, and Waterhouse (1999) argue that there exists a “chain of relations from teacher thinking to the outcomes of student learning” (p. 67).

That said, researchers in this area recognize that teacher thinking is not immune from the effects of contextual factors. Prosser and Trigwell (1997) examined how perceptions of the instructional context could alter teaching approaches, and Lindblom-Ylänne, Trigwell, Nevgi, and Ashwin (2006) found institutional and disciplinary variation in faculty approaches to teaching. What is left unexamined in this line of inquiry, however, is how the context influences the relationship between thought and action.

For this and other reasons, the research program on faculty thinking and related assumptions regarding the functional relationship between thinking and behavior has come under criticism in recent years. First, terminological confusion plagues the literature, as researchers have operationalized “thinking” using a variety of constructs (Kane, Sandretto, & Heath, 2002). For example, in his review of 13 studies on faculty thinking, Kember (1997) noted that researchers had used the following terms, “orientations, conceptions, beliefs, approaches, and intentions” (p. 256) and that few definitions
had been offered for these constructs. Second, some researchers suggest that higher-order constructs such as “approaches” to teaching are so abstract and decontextualized that they bear little resemblance to actual decisions made in specific teaching situations (Eley, 2006; Norton, Richardson, Hartley, Newsstead, & Mayes, 2005). In particular, some argue that research on approaches to teaching should go beyond the student/teacher-centered dichotomy and that “a strong opposite ‘either/or’ positioning of the approaches does not do justice to the nature of the phenomenon” (Postareff & Lindblom-Ylänne, 2008, p. 120). Finally, little work has been done to expand on the 1994 paper by Trigwell, Prosser, and Taylor regarding the precise nature of faculty beliefs about student learning. As such, little is known about the characteristics of these beliefs, and instead what can be considered a proxy measure (i.e., approaches to teaching) has been used in its place. Thus, the field’s knowledge of faculty beliefs is hindered by a lack of empirical work on this foundational construct, not to mention how these beliefs interact with other psychological and contextual factors to shape actual educational practice.

Research on K-12 Teacher Cognition

In contrast, an extensive literature exists on K-12 teacher cognition in general, and on pedagogical beliefs in particular. (See reviews in Fives & Buehl, 2012; Pajares, 1992.) For example, researchers have found that the implementation of math curriculum is strongly influenced by teachers’ beliefs about student abilities and learning (Ball, 1988; Nathan & Koedinger, 2000). A core idea from this literature is that teachers do not simply enact curriculum in the classroom but instead are complex decision-makers whose problem-solving capabilities are shaped by a combination of the characteristics (and constraints) of cognition as well as features of the instructional situation (Lee & Porter, 1990; Shavelson & Stern, 1981).

Beliefs about student learning are particularly influential because they influence the specification of problem-solving situations and subsequent strategies in unstructured or ill-defined situations. Fives and Buehl (2012) characterized the role that beliefs play in educational settings in terms of filtering new information, framing or defining tasks, and guiding subsequent action. In elaborating on the framing function of beliefs, Nespor (1985) highlighted the fact that the task environment undergoes a translation process from its objective state (as perceived by a theoretically omniscient observer) to a more concrete, subjective form as an individual actually thinks about how to solve a specific problem. Beliefs are thought to play a particularly important role in this process because they dictate or guide which features of the task will be noticed and responded to. In addition, because beliefs include what Nespor (1985) calls strong “existential assumptions” (p. 11) about the nature of reality, they may constitute the conceptual grounds upon which all subsequent decisions unfold.
In cognitive science, this process of task definition and decision-making is known as searching through an internal “problem space” (Newell & Simon, 1972). Specifically, this task entails identifying its overall parameters, its primary goal, and possible strategies for accomplishing it. In situations where a clearly defined and delimited task (e.g., solving a jigsaw puzzle), the articulation of the problem space and corresponding goals and strategies may be readily apparent. However, in rapidly changing environments where tasks may be poorly defined (e.g., a classroom), goals and strategies may be less obvious, and features of the problem space may “emerge” in real-time (Lee & Porter, 1990). In cases such as these, Newell and Simon (1972) theorized that rule-like operators could be used as cognitive shortcuts (i.e., heuristics) in order to save time and cognitive load when determining which strategies to use. Research suggests that beliefs may act as a particularly influential type of heuristic in its filtering, framing, and guiding functions (Fives & Beuhl, 2012).

As researchers of cognition began to focus on problem-solving in naturalistic settings, they began to pay close attention to the subtle interactions between the task situation, perceptual processes, and problem-space construction in what Greeno (1998) called the situative approach. This approach is grounded in theories of situated and embodied cognition that emphasize how cognitive activity in the real-world is distributed among “mind, body, activity, and culturally organized settings” (Lave, 1988, p. 1). Researchers in this tradition pay particular attention to perception, and how teachers can become attuned over time to features in their environment that enable or facilitate certain actions (e.g., departmental norms, classroom layout). These perceived affordances may also act as decision heuristics that guide decision-making. Importantly, these perceived affordances interact with other cognitive schemata (e.g., instructional goals, beliefs) to influence how teachers construct the problem space for teaching (Greeno, 1998; Lee & Porter, 1990).

As a result, this approach advances a view of behavior that emphasizes the non-linear and dynamic nature of cognition and decision-making such that it is highly unlikely that a single variable will unilaterally dictate or shape educational practice.

I suggest that the situative view is particularly important for research on postsecondary teachers, given that they typically function with a high degree of autonomy in regard to teaching, while at the same time being “embedded in an organizational matrix” of influences including their discipline, profession, and institution that constrain and/or enable certain practices (Umbach, 2007a, p. 263). Given the lack of knowledge about the nature of these beliefs among postsecondary teachers, in the first part of the study I focus on the fundamental question of the beliefs faculty have about student learning and any underlying dimensionality they may exhibit. Then, in the second part of the study I explore how these beliefs shape the emergent problem spaces for teaching specific classes.
METHODS

The design for the study is a qualitative case study, which is an intensive analysis of a single bounded unit (Yin, 2008). The case focuses on 56 math and science faculty at three large research universities who taught undergraduate courses in the spring of 2010. For the analyses of two instructors’ decision-making processes, I also use a concurrent mixed methods design that includes both interviews and classroom observations (Tashakkori & Teddlie, 2002).

Research Sites and Sampling Procedures

The research sites for this study were three public research institutions in the United States with similar numbers of undergraduate students and active pedagogical reform initiatives underway at the time of data collection. I selected research universities due to their large number of undergraduate students trained in math and science disciplines. The analysis focused on math, physics, chemistry, biology, and geology because the larger study from which it is drawn was funded by the National Science Foundation, which is focused on these areas. The course component of interest for this study was the classroom component (i.e., the lecture) instead of discussion or laboratory sessions. The sampling frame for the study included 263 individuals listed in the spring 2010 timetable as the instructor of record. The individuals listed in the timetables spanned a variety of appointment types including part-time and/or non-tenure-track instructors and tenure-track faculty.

These distinct appointment types are included under the single descriptor of “faculty” in this study for purposes of terminological simplicity, largely due to the fact that the focus of my analysis foregrounds cognitive characteristics of instructors above and beyond other factors that may contribute to variations in teaching practice. I contacted individuals up to two times by email inviting their participation in the study, and 57 faculty (22% of the initial sample frame) participated in the study. (See Table 1.) However, one respondent requested that his interview not be recorded. Thus, the total sample for the study was 56.

Limitations to the study include self-selection bias and the lack of data regarding tacit or subconscious beliefs of respondents. Further, all conclusions should be considered in light of the fact that respondents self-selected into the study and that the sample represents a small portion of math and science faculty teaching in U.S. research universities, which means that the results cannot be generalized to a broader population. Finally, important factors that influence postsecondary teaching (e.g., appointment type) are not explored in this paper given the focus on beliefs, which necessarily obscures elements that likely influence real-world practice.
### Table 1

**Description of Sample**

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>22</td>
<td>39%</td>
</tr>
<tr>
<td>Male</td>
<td>34</td>
<td>61%</td>
</tr>
<tr>
<td><strong>Institution</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>18</td>
<td>32%</td>
</tr>
<tr>
<td>B</td>
<td>20</td>
<td>46%</td>
</tr>
<tr>
<td>C</td>
<td>18</td>
<td>32%</td>
</tr>
<tr>
<td><strong>Discipline</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math</td>
<td>18</td>
<td>32%</td>
</tr>
<tr>
<td>Physics</td>
<td>11</td>
<td>19%</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8</td>
<td>16%</td>
</tr>
<tr>
<td>Biology</td>
<td>11</td>
<td>19%</td>
</tr>
<tr>
<td>Earth/space science</td>
<td>8</td>
<td>14%</td>
</tr>
<tr>
<td><strong>Level of course</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower division</td>
<td>38</td>
<td>68%</td>
</tr>
<tr>
<td>Upper division</td>
<td>18</td>
<td>32%</td>
</tr>
<tr>
<td><strong>Size of course</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 or less</td>
<td>10</td>
<td>18%</td>
</tr>
<tr>
<td>51–100</td>
<td>17</td>
<td>31%</td>
</tr>
<tr>
<td>101–150</td>
<td>9</td>
<td>16%</td>
</tr>
<tr>
<td>151 or more</td>
<td>20</td>
<td>35%</td>
</tr>
<tr>
<td><strong>Position type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecturer/instructor (non-tenure-track)</td>
<td>29</td>
<td>51%</td>
</tr>
<tr>
<td>Assistant professor</td>
<td>6</td>
<td>11%</td>
</tr>
<tr>
<td>Associate professor</td>
<td>4</td>
<td>7%</td>
</tr>
<tr>
<td>Professor</td>
<td>17</td>
<td>31%</td>
</tr>
</tbody>
</table>

*Data Collection*

The data collected in this study include an interview and two classroom observations with each respondent. A team of three researchers (the first author and two graduate students) conducted all data collection activities. A single researcher observed two class periods of each respondent, with interviews typically taking place immediately before or after an observed class. The interview protocol for this study used a semi-structured approach, in which all respondents were encouraged to explore new ideas tangential to the questions posed to them (Spradley, 1979). Thus, while we asked each respondent all of the questions in the protocol, the length and depth of an-
Answers varied considerably. The interviews were conducted in respondents’ offices and lasted approximately 45 minutes. The audio recordings were later transcribed.

Questions in the protocol salient to this study include:

• What is your view about how people best learn key concepts in your field at the undergraduate level?
• Is this view evident in how you plan and teach this course?
• What factors did you take into account as you planned the course?

In addition to the interviews, each respondent was observed for two full class periods using the Teaching Dimensions Observation Protocol (TDOP). The TDOP was developed to code the participating instructors’ use of teaching methods (e.g., small-group work), types of cognitive engagements offered by the instructor (e.g., problem solving, creating), and instructional technologies at five-minute intervals throughout the class period. In order to establish inter-rater reliability, the analysts participated in a three-day training and coded three videotaped undergraduate classes. (See Hora & Ferrare, 2013 and 2014 for more information.) The results of the inter-rater reliability, using Cohen’s Kappa for each pair of raters (averaged across the three categories), are: Analyst 1/Analyst 2 (.699), Analyst 1/Analyst 3 (.741), Analyst 2/Analyst 3 (.713).

**Data Analysis**

I analyzed the data for this study in two stages. First, I analyzed all 56 interview transcripts to identify belief types and any underlying dimensionality to these beliefs. Second, I analyzed the planning and classroom practices of two instructors to investigate the specific mechanisms by which beliefs influenced (or not) their teaching practices.

**Stage 1: Identifying Belief Types and Their Dimensionality**

The first step in the analysis involved segmenting the data into manageable units using a structured coding scheme. I first used an open-coding process to create the coding scheme, followed by the constant comparative method which entailed comparing successive instances of a newly created code to previous instances in order to confirm or alter the code (Glaser & Strauss, 1967). For this phase of the analysis, I worked with another member of the research team, and we independently developed our own code lists, then met to revise and refine a final coding scheme. After applying the coding scheme to five transcripts, we assessed inter-rater reliability by calculating the percentage of agreement between the analysts in applying the codes (89%). We then applied the coding scheme to all 56 transcripts using NVivo® qualitative data analysis software, which resulted in an extensive library of coded text. Then, I analyzed all text fragments coded as “beliefs about student learning” using
the constant comparative method, which resulted in the identification of 15 types of beliefs. As a reliability check, the other researcher reviewed 25% of the raw data coded as “beliefs about student learning” and confirmed the initial finding of 15 belief types.

Next, in order to examine the degree to which the 15 beliefs exhibited dissimilarity or similarity (i.e., underlying dimensionality), I used a combination of data reduction and inductive techniques to analyze the interview data. First, a cluster analysis was performed, which is a non-statistical procedure for partitioning objects into groups based on (dis)similarity as measured through a distance matrix—in this case binary squared Euclidian distance. The matrix used in this analysis included respondents as rows and belief types as columns, with a “1” indicating the presence of a belief type and “0” indicating its absence. In this analysis I used an agglomerative form of hierarchical clustering. The clustering algorithm used in this analysis is referred to as Ward’s Method. I then conducted additional analyses such as the “furthest neighbor” method of clustering, which supported these results.

Next, as a complement to the cluster analysis, I used a nonmetric multidimensional scaling (MDS) procedure to analyze the data. Instead of locating belief types into mutually exclusive groups as is done in cluster analysis, multidimensional scaling graphically represents the similarity (or dissimilarity) between themes as distances in a two-dimensional space. In this analysis I used Euclidean distance to identify theme proximities. Multidimensional scaling also provides a measure of the degree to which the resulting graph is consistent with a perfectly proportional graph of code relationships, known as the “stress” value. Kruskal and Wish (1978) suggest that a cutoff for acceptable stress exists between 0.0 and 0.2, and the stress value for the analysis performed for this thesis was .018.

Then, in order to interpret the meaning behind these results I organized the original text fragments coded as “views of learning” into the two groups suggested by the cluster and MDS analyses, and examined the data to identify whether each group varied according to a discernable theme. I derived a new set of open codes while reviewing these data, and ultimately a single theme emerged that best described the grouping of the belief types.

**Stage 2: Case Studies of Individual Instructors**

The next stage of the analysis entailed conducting in-depth case studies of two instructors. Given widespread interest in encouraging “interactive” teaching techniques, and whether beliefs and/or situational constraints are related to the use of these techniques, I identified two instructors whom we had observed using interactive approaches in the classroom. While no objective standard exists to determine the degree of an instructor’s “interactivity,” I selected instructors who exhibited a high degree of question asking and diverse types of student cognitive engagements in the classroom. Once two
individuals meeting the criteria for inclusion were identified, I analyzed their interview transcripts using thematic network analysis—a structured approach for identifying relationships between concepts in a graphic and time-ordered fashion (Miles & Huberman, 1994).

I analyzed each respondent’s transcript to identify the following key elements of instructional decision-making based on evidence from the teacher cognition literature (e.g., Shavelson & Stern, 1981): influential schemata (i.e., beliefs and goals), personal attributes (i.e., prior experiences with the course), perceived affordances (i.e., how the context influenced teaching), and curricular artifacts. Finally, I analyzed the classroom observation data for each instructor by calculating the proportions that a particular code was observed in relation to all possible five-minute intervals.

Then, I analyzed each transcript to identify explicit statements regarding relationships among the variables using two criteria: (a) respondents’ statements that indicated a relationship between factors, and (b) analyst interpretation of associations between factors. For example, one of the faculty included in this analysis clearly stated that the layout of the classroom (i.e., a perceived affordance) precluded the use of the chalkboard and thus led to the planned use of PowerPoint slides instead. These results were then used to develop a graphic that depicted the entire set of variables that were evident as a class was being planned and taught. Specific relationships among a more limited number of variables were then singled out and named as “network #1” or “network #2,” which represents associations among combinations of these variables.

Results

In this section, I report the results regarding faculty members’ beliefs for how undergraduate students learn, the underlying dimensionality of these beliefs, and in-depth analyses of the two selected faculty members that examines the relationship among cognition, context, and teaching.

Belief Types: Entire Study Sample

The analysis of interview data resulted identifying 15 distinct themes for student learning across the study sample. (See Table 2.) The range of reported beliefs per person varied from zero references to seven references. Each belief is described in the following section.

1. Practice and Perseverance. Twenty-seven respondents reported the belief that student learning is best achieved when students study and practice problem-solving diligently on their own time. A core feature of this belief is that learning occurs over time and through sustained engagement with the material. As one respondent stated, students “will not learn until they do it a thousand times.” Interestingly, several faculty described this belief in...
### Table 2

**Faculty beliefs about student learning**  
(*n* = 56)

<table>
<thead>
<tr>
<th>Belief Type</th>
<th>Number of References</th>
<th>Belief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Practice and perseverance</td>
<td>27</td>
<td>Learning comes through prolonged effort on solving conceptual and computational problems by self.</td>
</tr>
<tr>
<td>2 Variability</td>
<td>20</td>
<td>All people learn differently (e.g., visual, auditory, hands-on, etc.).</td>
</tr>
<tr>
<td>3 Hands-on/application</td>
<td>18</td>
<td>Learning is best facilitated through active, hands-on engagement with the material (e.g., labs, field-work).</td>
</tr>
<tr>
<td>4 Articulating</td>
<td>16</td>
<td>Students learn best when vocally articulating their own thoughts, ideas, and problem-solving processes to others.</td>
</tr>
<tr>
<td>5 Not in the classroom</td>
<td>16</td>
<td>The classroom (i.e., the lecture) is not the best venue for learning.</td>
</tr>
<tr>
<td>6 Visualizations</td>
<td>13</td>
<td>Students learn effectively when material is put into visual or other physical form.</td>
</tr>
<tr>
<td>7 Active construction</td>
<td>12</td>
<td>Students must actively develop their own understandings of the material.</td>
</tr>
<tr>
<td>8 Connection to experience</td>
<td>10</td>
<td>Learning is facilitated when course material is explicitly linked to students’ own experiences.</td>
</tr>
<tr>
<td>9 Scaffolding</td>
<td>8</td>
<td>Learning is facilitated when course topics are presented in a sequential fashion from least to most difficult.</td>
</tr>
<tr>
<td>10 Examples</td>
<td>5</td>
<td>Students learn from concrete examples and illustrations of course material.</td>
</tr>
<tr>
<td>11 Explication</td>
<td>5</td>
<td>Learning is facilitated through the clear explanation of topics or problems.</td>
</tr>
<tr>
<td>12 Repetition</td>
<td>4</td>
<td>Students learn through repeated exposure to a topic or idea.</td>
</tr>
<tr>
<td>13 Osmosis</td>
<td>3</td>
<td>Students learn by being in the presence of an expert (i.e., an academic).</td>
</tr>
<tr>
<td>14 Memorizing</td>
<td>2</td>
<td>Learning is accomplished through memorizing facts or computational rules.</td>
</tr>
<tr>
<td>15 Individualized instruction</td>
<td>2</td>
<td>Learning is facilitated through one-on-one interaction with an instructor.</td>
</tr>
</tbody>
</table>
physical or even violent terms, such as “banging one’s head against the table,” “mental weight lifting,” and “grinding away at it,” which underscores the view of learning as one that requires a significant investment of time and energy from the student. Finally, several respondents described this belief in terms of homework assignments, where the class period acts as a staging ground for introducing problems that students then take home to probe more deeply.

2. Variability. The next most regularly cited belief was that the fundamental nature of learning varies from person to person (20 respondents). One respondent characterized this belief as “the eyes, ears, and handwriting” theory of learning, meaning that some people are auditory learners while others learn most effectively through visual or text-based methods. As such, no single type of instruction or learning milieu is adequate for all students, but instead, different people will benefit from different types of instruction and course formats. One of the implications of this belief is the subsequent attempt by some faculty to provide what is known as “differentiated instruction,” in which faculty provide different avenues for learning the material to students based on their aptitude and learning preferences. For example, one chemist stated that he deliberately planned his classes to include lectures, hands-on exercises, readings, and web-based modules based on his belief about students’ variability in learning styles.

3. Hands-On/Application. Eighteen respondents reported the belief that learning takes place when students are actively engaged with course material in a hands-on manner. This type of learning was often associated with venues such as laboratories or fieldwork sites where learning does not occur through the passive reception of information but through active involvement with the subject matter. For example, a physics faculty member stated that students should take the principles of physics gleaned from their classes or readings and “apply them to real things.”

4. Articulating. Sixteen respondents expressed the belief that learning occurs when students are forced to articulate their own understanding of the material to their peers or the instructors. That is, an especially effective way to learn something is to be forced to teach it, because the act of verbalizing one’s level of comprehension for a given topic clarifies for the audience whether the interlocutor genuinely understands the material.

5. Not in the Classroom. Sixteen respondents reported that learning best takes place outside of the classroom. In other words, faculty expressing this belief felt that of all possible learning environments (e.g., classrooms, laboratories, field-work, etc.) the classroom format, particularly large “lecture-style” classes, was the least amenable to facilitating student learning. In several cases, particularly among faculty from biology and geology, respondents stated that students really understand how to “do science” only when they design studies or collect data in the field.
6. Visualizations. Thirteen respondents expressed the belief that students learn most effectively when course content is put into visual or other physical form. This belief is based on the assumption that understanding ideas in their abstract form is harder for students than learning through its physical manifestation. For several faculty, this belief simply entailed projecting PowerPoint slides of images that illustrated the material (e.g., RNA sequences, volcanic eruptions), while others used more complex demonstrations or models to visualize abstract ideas.

7. Active Construction. Twelve respondents reported the belief that learning is dependent on students actively constructing their own unique understanding of course material. In several cases, they used “construct” to describe the learning process, and three faculty specifically referenced constructivist learning theories. An important idea underpinning these references was that students do not rely on the instructor’s formulation of a concept or the textbook; but as one chemistry faculty noted, “Successful students reformulate it (course material) in their own terms.” This belief differs from the hands-on/ application belief in articulating the type of reasoning that best facilitates learning, and not just the type of learning activity students should engage in.

8. Connection to Experience. Ten respondents expressed the belief that students learn best when the connection between the material and their own lives is made explicit. Five respondents used the word “motivate” to explain this phenomenon, as they felt that students should not be expected to be excited about the material on their own but that instructors had to clearly explain why the topic was relevant to their own lives and future careers.

9. Scaffolding. Eight respondents expressed the belief that student learning is best achieved when instructors effectively sequence course material. This scaffolding of material can take place in a variety of ways, from introducing basic concepts first followed by more complex material, or by providing concrete illustrations before delving into more abstract principles.

10. Examples. Five respondents expressed the belief that students best learn when given content-rich and real-world examples of course material. That is, providing abstract principles or theorems with little or no concrete illustrations regarding how they either can be used to solve actual problems, or how they appear in the natural world, does not adequately engage students or provide them with ways to envision applying these ideas in their own problem-solving.

11. Explication. Five respondents reported the belief that students require explicit, step-by-step descriptions of course material, particularly at the early undergraduate level. For these respondents, a key antecedent to learning is the instructor’s clear explanation of the material. For example, one math instructor answered the question regarding beliefs about student learning with the short reply, “You explain the principles and then they have to practice it—that’s it.”
12. **Repetition.** Four respondents stated that effective learning requires repetition, particularly for students with limited backgrounds or aptitude. That is, by reviewing topics regularly and focusing on particularly important or challenging concepts several times, instructors create an environment in which students can learn effectively.

13. **Osmosis.** Three respondents expressed the belief that students learn by being exposed to high-quality researchers. As one biology faculty stated, all students should take courses from active researchers who can share cutting-edge ideas with their classes, because they have access to information and opportunities that other instructors do not.

14. **Memorizing.** Two respondents reported the belief that memorization was a key facet of learning, particularly in math and science. As one biology faculty stated, biology is a “foreign language” with a substantial amount of new terms and concepts. Thus, a key component of learning requires students to memorize and then learn to use this new language.

15. **Individualized Instruction.** Finally, two respondents expressed the belief that learning best occurs in one-on-one situations where the faculty member can provide individualized instruction. In venues such as office hours, the instructor can help students get past “cognitive humps” and assist them in recognizing where they are encountering challenges with the material.

**Belief Types: Discipline**

Given the important role that the discipline plays in faculty work, I next analyzed the belief types according to the disciplinary affiliation of each respondent. The results should be cautiously interpreted given the small sample size per group, and I would warn against making generalizations to entire disciplinary groups. Instead, these data provide a preliminary glimpse at potential variations in faculty pedagogical beliefs according to disciplinary affiliation. (See Table 3.)

For example, some beliefs are notable in the relatively high or low numbers of references from particular disciplinary groups. While all groups reported the belief of practice and perseverance, the math faculty in the study did so with the highest proportion (i.e., 76%). Chemistry faculty reported the belief about visualizations the most (67%), followed by geology faculty (38%), but the other groups referenced this belief with less frequency. Their reports may be due to the greater frequency of visual imagery in these fields and courses, in contrast to a more symbolic discipline such as mathematics. Conversely, some interesting results pertain to groups that did not make any references to particular beliefs. For example, no chemistry faculty reported the not-in-the-classroom belief, whereas other groups reported the belief with some regularity.
Table 3

Belief Types by Disciplinary Group
(n = 56)

<table>
<thead>
<tr>
<th>Belief Type</th>
<th>Biology (n=11)</th>
<th>Chemistry (n=9)</th>
<th>Math (n=17)</th>
<th>Geology (n=8)</th>
<th>Physics (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Practice and perseverance</td>
<td>3 (27%)</td>
<td>4 (44%)</td>
<td>13 (76%)</td>
<td>2 (25%)</td>
<td>5 (45%)</td>
</tr>
<tr>
<td>2 Variability</td>
<td>4 (36%)</td>
<td>6 (67%)</td>
<td>5 (29%)</td>
<td>1 (13%)</td>
<td>5 (45%)</td>
</tr>
<tr>
<td>3 Hands-on/application</td>
<td>4 (36%)</td>
<td>3 (33%)</td>
<td>4 (24%)</td>
<td>5 (63%)</td>
<td>2 (18%)</td>
</tr>
<tr>
<td>4 Articulating</td>
<td>5 (45%)</td>
<td>2 (22%)</td>
<td>4 (24%)</td>
<td>3 (38%)</td>
<td>2 (18%)</td>
</tr>
<tr>
<td>5 Not in the classroom</td>
<td>4 (36%)</td>
<td>0</td>
<td>5 (29%)</td>
<td>4 (30%)</td>
<td>4 (36%)</td>
</tr>
<tr>
<td>6 Visualizations</td>
<td>2 (18%)</td>
<td>6 (67%)</td>
<td>1 (6%)</td>
<td>3 (38%)</td>
<td>1 (9%)</td>
</tr>
<tr>
<td>7 Active construction</td>
<td>4 (36%)</td>
<td>1 (11%)</td>
<td>4 (24%)</td>
<td>1 (13%)</td>
<td>1 (9%)</td>
</tr>
<tr>
<td>8 Connection to experience</td>
<td>3 (27%)</td>
<td>2 (22%)</td>
<td>0</td>
<td>2 (25%)</td>
<td>3 (27%)</td>
</tr>
<tr>
<td>9 Scaffolding</td>
<td>1 (9%)</td>
<td>3 (33%)</td>
<td>2 (12%)</td>
<td>1 (13%)</td>
<td>1 (9%)</td>
</tr>
<tr>
<td>10 Examples</td>
<td>0</td>
<td>2 (22%)</td>
<td>2 (12%)</td>
<td>0</td>
<td>1 (9%)</td>
</tr>
<tr>
<td>11 Explication</td>
<td>0</td>
<td>0</td>
<td>4 (24%)</td>
<td>0</td>
<td>1 (9%)</td>
</tr>
<tr>
<td>12 Repetition</td>
<td>1 (9%)</td>
<td>2 (22%)</td>
<td>1 (6%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>13 Osmosis</td>
<td>1 (9%)</td>
<td>2 (22%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14 Memorizing</td>
<td>1 (9%)</td>
<td>1 (11%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15 Individualized instruction</td>
<td>1 (9%)</td>
<td>0</td>
<td>1 (6%)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Dimensionality of Beliefs

As previously noted, some researchers investigating faculty beliefs argue that they exist on a continuum from teacher-centered/content-oriented to a student-centered/learning-oriented (e.g., Samuelowicz & Bain, 2001). Given this widespread notion, I used exploratory data reduction and inductive analytic techniques to examine whether an underlying dimensionality could be discerned in these new data. First, I conducted a cluster analysis. (See Figure 1.)

The primary output in cluster analysis is the dendrogram—a diagram that illustrates the clusters and the decisions the algorithm made to attain them. At a certain stage of the analysis, the algorithm organized the belief themes into two distinct clusters, with the most widely reported belief not falling within either group. The first cluster (hereafter Cluster A) includes the following beliefs: osmosis (#13), individualized instruction (#15), memorizing (#14), repetition (#12), explication (#11), scaffolding (#9), examples (#10), visualizations (#6), and connection to experience (#8). The second cluster (hereafter Cluster B) includes the following beliefs: hands on/application (#3), not in the classroom (#5), articulating (#4), active construction (#7), and variability (#2).

The most highly reported belief of practice and perseverance (#1) did not cluster with the other groups, which suggests that either hierarchical
cluster analysis is not a necessarily good fit for these data, or that this belief was sufficiently dissimilar from the others that it was not included in the two main clusters. That is, respondents who reported the practice and perseverance belief may have done so in conjunction with the other 14 beliefs but in no distinct pattern, such that little to no similarity among the beliefs could be discerned by the cluster analysis. Subsequent analyses using the furthest neighbor (i.e., complete linkage) method resulted in similar groupings, thereby indicating some stability to the results.

Second, I conducted a nonmetric multidimensional scaling (MDS) analysis that depicts the proximities between pairs of objects as distances in low dimensional spaces. The arrangement of the belief types in the MDS graphs was similar to the clusters identified in the cluster analysis. The large group in the center of the graph overlaps with beliefs within Cluster A (e.g., osmosis (#13), individualized instruction (#15), memorizing (#14), repetition (#12), explication (#11), scaffolding (#9), and examples (#10). A more diffuse grouping along the bottom of the graph includes beliefs from Cluster
B (e.g., hands on/application (#3), not in the classroom (#5), articulating (#4), and active construction (#7). Both variability (#2) and practice and perseverance (#1) are located in spaces distant from these two groups (see Figure 2), which suggests that these beliefs are dissimilar from beliefs that appear in Clusters A and B.

Since neither data reduction technique provides any information about the nature of the results, a subsequent interpretive step is necessary. To do this I reexamined the interview data which resulted in identifying a single theme that best explained the variation between the two clusters: the agent who is seen as playing the principal role in constructing knowledge and meaning—the teacher or the student. In Cluster A, it is the teacher who constructs meaning and presents concepts to students through a variety of teaching approaches. Students learn by being in their mere presence (osmosis), one-on-one instruction (individualized), memorizing facts that the teacher presents (memorizing), clearly explaining the material (explication), and so on. Thus, learning takes place largely through students’ internalization of knowledge that the teacher has constructed and presented.

In Cluster B, it is the student who constructs meaning. The students engage in hands-on experiences of their own (hands on/application), learns on their own outside of the classroom (not in the classroom), vocalizes their own thoughts and ideas (articulating), and so on. Thus, learning occurs primar-
ily through the student’s own construction of knowledge. In the case of the two most highly cited beliefs (i.e., practice and perseverance belief, and variability), I suggest that these beliefs cannot be interpreted in relation to this dimension of student- or teacher-centered knowledge construction. Instead, these beliefs represent their own unique views about teaching and learning that do not necessarily depend on which agent is constructing meaning.

Further, these data suggest that faculty cannot be characterized entirely as having either a student-centered or a teacher-centered set of beliefs about learning. This is because 66% of the respondents in the study (37) reported beliefs that were not limited solely to Cluster A, Cluster B, or either of the stand-alone beliefs. (See Table 4.) While 19 individuals did report beliefs that lay solely in one of these categories, a majority reported beliefs that cut across these categories.

These results suggest that the dimensionality underlying these beliefs is not an either-or proposition in which individual faculty must be (or can be) assigned to a single “type” of belief (Postareff & Lindblom-Ylänne, 2008). Instead, individuals may hold a variety of beliefs along a single dimension comprised of two poles representing student- and teacher-centered beliefs, or there are actually two (or more) dimensions about which individuals may hold strong or weak beliefs on different dimensions simultaneously (Eley, 2006).

### Table 4

**Distribution of Respondents Reporting Beliefs in Single Clusters or Across Clusters (n=56)**

<table>
<thead>
<tr>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed (across belief types)</td>
</tr>
<tr>
<td>Only Cluster A</td>
</tr>
<tr>
<td>Only Cluster B</td>
</tr>
<tr>
<td>Only Practice/perseverance</td>
</tr>
<tr>
<td>Only variability</td>
</tr>
</tbody>
</table>

The Role of Beliefs in Postsecondary Teaching:

**Two Cases of Real-World Practice**

Finally, to examine the role that beliefs play in real-world practice, in-depth descriptions of the decision-making processes of two faculty are presented in this section. In addition, I also explore the degree to which other cognitive
schemata (e.g., goals), personal attributes, perceived affordances, curricular artifacts, and course content influence the development of the problem space for course planning and classroom instruction.

**Dr. Russell (Department of Physics)**

The first case describes the instructional decision-making of Dr. Russell (pseudonym), a full-time lecturer in the Physics Department at Institution A. At the time of data collection, Dr. Russell was teaching the third quarter in the calculus-based introductory physics series. In response to the question regarding his views about student learning, Dr. Russell responded:

> My view is that it [student learning] is incredibly varied. As many people as there are, there are probably that many different ways that humans attain knowledge. But on the other hand, there may be a best way overall and I would say that that is personal perseverance. Also I think, for many students, the breakthrough is when they realize they need to take physics and apply it to things. If they understand how a fluorescent light works, that is when they have started to really learn it.

In this response Dr. Russell expressed three different beliefs about student learning: variability (#2), practice and perseverance (#1), and hands-on/applications (#3). In addition, Dr. Russell later added that his classes were “definitely not a key to them [students’] understanding,” which is the belief that learning takes place outside the classroom (#5). Additionally, he noted that learning is easier when “you can see it,” which refers to visualizations (#6). In expressing such a range of views, Dr. Russell is one of the 37 faculty in this study whose beliefs did not fall solely within one of the two identified clusters nor in the underlying belief of practice and perseverance.

The next question invited Dr. Russell to comment about the degree to which these beliefs were evident in his teaching. He responded that the primary factor he perceived as influencing his practice was class size. He volunteered this observation as a major influence on how he thought about the teaching task (i.e., defining the problem space) but did not add a clear link between how class size mediated the relationship between beliefs and teaching. However, later in the interview, Dr. Russell returned to this point by commenting that it was challenging to do hands-on activities in large lecture halls. Thus, he perceived class size as an impediment to the realization of his hands-on/applications belief about student learning (#3). Nevertheless, despite the class size, he attempts to “get them to interact” by frequently asking questions.

Dr. Russell also reported that several other elements influence how he plans and teaches his classes. First, he expressed a goal for the class that he directly linked to his classroom behaviors—that of having the students directly engaged during the class. Second, Dr. Russell noted that his prior experiences
as a student regarding topics he had found confusing and his experiences as an instructor regarding what had worked (and not worked) in previous years informed his current practice. Third, Dr. Russell perceived that several contextual factors, besides class size, represented affordances to his teaching. These included the curriculum, which demarcated the type and sequencing of content in the course, and the type of students in his course (i.e., engineering majors), which led to including numerous practical examples in his lectures. Thus, his pedagogical beliefs, instructional goals, prior experience, and perceived affordances all played a role in how he conceptualized the instructional problem space.

During the class that I observed, Dr. Russell stated that he planned to discuss the harmonic oscillator equation, use a large pendulum hanging from the ceiling as a demonstration, and then to use the equation to study the pendulum’s motion. The specific teaching methods that he planned to use included asking several verbal questions and clicker (i.e., electronic response system) questions, demonstrations, and the chalkboard for writing out equations. Importantly, Dr. Russell observed that his decision to use demonstrations was influenced by the presence of a dedicated staff person who managed demonstration equipment for the department, which reduced the demands on his own preparation time. In the observed class, Dr. Russell began by outlining three main goals for the day’s class: to discuss harmonic oscillators, energy, and the simple pendulum equation. He then discussed Hooke’s Law while lecturing at the chalkboard, and demonstrated the principle using the pendulum. The remainder of the class followed this pattern of teaching behaviors: lecturing at the chalkboard (observed in 90% of all five-minute intervals), demonstration (70%), and posing display questions seeking new information (80%). Figure 3 is a graphic depiction of the data described in this analysis, and two thematic networks that indicate associative relationships among beliefs, other factors, and teaching practice.

Thematic network #1 represents the relationship among the visualizations belief (#6), the perceived affordance related to staff support for demonstrations, and the following teaching practices: the use of lecturing with demonstrations as a teaching method, the use of demonstration equipment, and the cognitive engagement of making connections to the real world. This network suggests that the visualizations belief and the perceived affordance interacted to articulate one aspect of the problem space, and the use of demonstrations during class. Thematic network #2 represents the relationship among the hands-on/application (#3) belief, the goal of involving students in class, and the teaching practice of posing verbal questions. This network suggests that the belief interacted with a goal to articulate another aspect of the problem space, which then led to the regular posing of questions during class. Based on these data, it appears that some of Dr. Russell’s beliefs, particularly that of hands-on/applications and visualizations, played a considerable role in
framing how he viewed the “problem” of teaching his class and in guiding which actions were best suited to meet his pedagogical goals (e.g., visually and verbally engaging students with the material).

**Dr. Wilson (Biology)**

The second analysis features Dr. Wilson, who was a full-time lecturer in the Biology Department. She had been at Institution B for over 10 years and was teaching a junior-senior level capstone course in molecular cell and developmental biology. In response to the question about student learning, Dr. Wilson stated:

Different people learn key concepts differently, and some students just prefer to listen. So I think that students have clear preferences for learning styles, and even when you try to be active in your teaching approach some students will only learn in the way that they find most comfortable for themselves, and they will refuse to participate in things they are not comfortable with.

This statement clearly indicates that Dr. Wilson held the variability belief (#2) about student learning. Dr. Wilson then characterized this view as a “student perspective” in that it placed the student and their preferences for learning at the center of considerations about instruction. In contrast, she felt that the “teacher’s perspective” emphasized the instructor’s considerations for the material over any thoughts about students’ abilities or learning styles. In viewing beliefs in this manner, Dr. Wilson articulated a dichotomy not dissimilar to the continuum advanced in much of the literature (e.g., Kember,
1997) as well as Clusters A and B identified in this study. Dr. Wilson then stated that she personally leaned toward the student perspective and believed that students learn best by being actively engaged in the material (hands-on/application #3), constructing their own understanding of the material (#7), and articulating (#4) their own ideas to instructors and/or peers. Dr. Wilson also reported her belief that much learning occurred outside of the classroom (#5). In sum, most of her beliefs lie in Cluster B. In expressing these beliefs she stated that having a dynamic classroom environment was an indispensable component to learning, which indicates that her beliefs played a strong role in framing the instructional problem space and suggesting specific teaching practices.

Dr. Wilson then noted that a significant constraint shaping her decision-making process is time, and whether she’d had a chance to figure out “the right sequence of things that I think will trigger them to really learn.” In the observed class, she had not had the time to convert some of the material from a “traditional lecture” into a more interactive modality and so relied on older lesson plans that included no interactive elements. The lack of time was largely due to her heavy workload of teaching three courses, advising students, and engaging in educational research. Despite these constraints, Dr. Wilson strove to reduce the amount of “pure” lecturing, mostly because she realized that she did not like this way of teaching and that it likely was ineffective. This sentiment coincided with the growth of a community of faculty engaged in science education on campus, which provided a rich resource of teaching tips and materials, and a supportive network of other like-minded educators that Dr. Wilson considered important, given the research-oriented mission of her institution.

For the observed class, Dr. Wilson planned on discussing synapse formation and eye anatomy. In terms of teaching methods, she planned to lecture as an introduction to the material, to “frame” the class period, and to introduce new terms. Dr. Wilson also planned on using clicker questions as a precursor to small group discussions, show PowerPoint slides, and pose several questions to students. The use of clickers, discussions, and asking questions can be viewed as being guided or informed by her Cluster B beliefs (e.g., hands-on learning). In the observed class, Dr. Wilson exhibited a variety of teaching methods including lecturing, question-asking, small group work, case studies, and illustrations. (See Figure 4.)

Thematic network #1 represents the relationship among three beliefs, Dr. Wilson’s prior experience in the classroom, and perceived affordances related to time constraints and supportive colleagues that collectively influenced her teaching. All of her beliefs fell within Cluster B, and several of her planned and observed practices were consistent with these beliefs, which suggests that her beliefs played a role in framing the instructional task and guiding subsequent action.
Finally, the substantial use of lecturing during the observed class (87% of all five-minute intervals) is notable given the dominance of student-centered beliefs that Dr. Wilson expressed. She provides a clear rationale regarding her lecturing—that at some point, an instructor just has “to say a few things or nobody will have a clue where to get started.” The coexistence of a high degree of lecturing and high proportions of interactive teaching techniques and a range of student cognitive engagement suggests that it may not be the case that faculty who value students’ construction of meaning (i.e., Cluster B beliefs) do not lecture and that lecturing does not automatically translate into unsatisfactory or inadequately engaging instruction.

**DISCUSSION**

In this section I elaborate on the results presented in this paper and explore implications of these findings for researchers, policymakers, and practitioners in the field.

**Advantages of a Situative Approach**

It is widely recognized that a variety of organizational, socio-cultural, and personal forces shape how faculty approach their work, and that investigations of what shapes teaching practice must take account of this critical fact (e.g., Austin, 1990; Umbach, 2007a). Many theories are available to explore these complex dynamics, including Bourdieu’s (1988) theory of social practice,
social cognitive theory (Bandura, 2001), and situated cognition theory to name but a few. An advantage of these integrative theories of behavior is that they avoid isolating a single variable as the primary determinant of social action such as beliefs and instead pose a dialectical relationship among the individual, their surroundings, and behavior.

In this article, I advance the proposition that the situative framework is a useful way to conceptualize these dynamics. In particular, the idea of the problem space foregrounds the fact that, when faced with a task, any given individual will actively construct his or her own interpretation of the nature of the problem and the best course of action to solve it. Thus, a truly objective or omniscient accounting of the problem of teaching exists only in theory and not in practice. Instead, how to address the task of teaching the harmonic oscillator equation or synapse formation is shaped in part by the unique background and belief systems of the instructor. It is important to recognize, however, that these interpretive processes do not unfold in a vacuum. Rather, the organizational and socio-cultural context in which the instructor works also plays an influential role in shaping how a class is ultimately planned and taught. The situative framework takes both of these facts into account but with the analytic focus placed squarely on the perceptual processes of individual actors in specific settings. This article represents an effort to begin exploring this rich theoretical terrain in the context of post-secondary teaching. In the remainder of this discussion, I explore some key aspects of the findings.

**Types of Beliefs**

The data reported in this article regarding the 15 distinct types of beliefs for student learning represent the first empirical evidence on this topic since the early studies of Prosser, Trigwell, and Taylor (1996). While prior research found five types of beliefs that varied according to the nature of learning (e.g., accumulating information), the findings reported here indicate more variability in faculty beliefs about how students learn. Two of these beliefs merit further consideration, given their prominence and potential for operating as existential assumptions about the nature of reality, with the result that they may play a strong role in shaping how faculty think about teaching and learning.

1. **Practice and perseverance.** The most commonly reported belief in the study was that students learn best when engaged in a diligent course of study with the material on their own time (27 respondents). This perspective—that hard work is a key feature of student learning and brings success at the undergraduate level in general, and in math and science disciplines in particular—is not without precedent. Some have pointed to practice and persistence as a critical predictor of student persistence in math and science disciplines (Drew, 2011). This conclusion is due in part to the perception
that these fields are by nature difficult to master. Without hours of study and practice, it will be difficult for students to learn and continue on to the next level of training.

Interestingly, evidence suggests that undergraduate student study habits are changing in ways that may conflict with this foundational belief. Babcock and Marks (2011) found that the average full-time student at four-year colleges studied 14 hours per week in 2003, as compared to 24 hours per week in 1961. Thus, the expectations faculty have regarding a fundamental aspect of student learning and success—that of practice and persistence—may not match the actual study habits of contemporary students as measured in hours spent studying per week. The implications for this misalignment is an important question that should be pursued in future research. It is particularly important given that policymakers and researchers tend to focus on the quality of teaching as one of the primary contributions to student attrition and poor learning outcomes, particularly in math and science disciplines (e.g., President’s Council of Advisors on Science and Technology, 2012). The widespread nature of the belief regarding persistence and practice suggests that, for many faculty in this study, poor student outcomes are largely due to the students’ amount of effort and not just to their own teaching. While I do not question the validity of either perspective, the tension between these different causes for poor outcomes (i.e., the student or the teacher) should be acknowledged by those engaged in instructional improvement.

2. Variability and learning styles. Another widely held belief is that how students learn varies from person to person (20 respondents). The belief that students learn according to different styles, and that differentiated instruction should be provided to students of different abilities and background, is widespread in the educational literature. In the context of math and science education, Felder and Silverman (1988) argued that teachers should meet the needs of all learning styles (e.g., auditory, sensory), and that when mismatches occur between these styles and faculty teaching, results include student boredom and poor performance. However, the idea that learners have different learning preferences independent of ability and content, and that these have corresponding implications for learning outcomes, is without basis in the empirical literature (Riener & Willingham, 2010). While research does support the notion that students do have preferences for learning, adapting teaching styles to learning preferences makes no statistical difference under controlled conditions. As a result, Reiner and Willingham (2010) argue that instructors should present information in an appropriate manner for the content and the level of prior knowledge of students, but not in terms of the different learning preferences of their students. It is important to note that the lack of experimental evidence does not prove that adapting teaching styles to student preferences has no impact on student learning in actual classrooms.
In any event, the salience of this cautionary note in relation to the data reported in this study is that faculty attempts to teach in accordance with various student learning styles are leading some instructors to diversify their pedagogical repertoire. One question raised by this finding is whether a differentiated approach to instruction, at least in terms of the use of particular teaching techniques, does in fact facilitate students in “making it their own” or if it results in an overly multi-modal and incoherent approach to instruction.

**UNDERLYING DIMENSIONALITY OF BELIEFS: THE AGENT CONSTRUCTING KNOWLEDGE OR MEANING**

The findings confirm prior research indicating that faculty beliefs can be characterized according to a student-centered or a teacher-centered perspective. However, the evidence presented in this article suggests that faculty beliefs cannot always be considered mutually exclusive categories to which individuals can be assigned. The results suggest instead that some faculty may hold more complex combinations of beliefs (Nespor, 1985). Further, the case studies indicate that these beliefs are also linked to and influenced by prior experience, goals, and perceived affordances, such that describing an individual’s pedagogical thinking in terms of a single type of belief is overly simplistic (Postareff & Lindblom-Ylänne, 2008). In addition, based on these data, no conclusions regarding the hierarchical structure of belief types whereby one belief subsumes all others (e.g., Trigwell, Prosser, & Taylor, 1996), or the inherent sophistication of particular beliefs can be made (Entwistle & Walker, 2000).

**The Complex Relationship among Beliefs, Context, and Teaching Behaviors**

Similarly, prior research suggests that pedagogical beliefs have a linear and direct effect on faculty teaching practices. For example, Kember (1997) stated that “a lecturer who holds an information transmission conception is likely to rely almost exclusively on a unidirectional lecture approach” (p. 270). Others have argued that individual variables (e.g., disciplinary affiliation) directly cause teaching behaviors, even if they assume “a simplicity and linearity” that may not exist in real-world settings (Umbach 2007a, p. 286).

The data reported in this article—that beliefs in practice are often too multi-faceted to be reduced to a single “type” and that they interact with prior experiences, goals, and perceived affordances of the organizational context to frame the teaching task and guide instructional decisions—raise questions about such conclusions. Instead, the evidence suggests that the data are more appropriately interpreted in light of prior research that indicates beliefs play an important role in defining tasks rather than unilaterally causing behavior (Nespor, 1987; Pajares, 1992).
A key aspect of this “framing” process is that beliefs define the parameters of new tasks or problems; as a result, a task such as teaching the harmonic oscillator equation itself can be seen in a variety of ways. Thus, the beliefs that Dr. Russell articulated defined the problem space in which he approached the teaching task. In particular, his beliefs that students must have a “breakthrough” and actually “apply [physics] to things” (i.e., the hands-on/application belief) suggests that Dr. Russell views the problem of learning in this instance as one contingent upon having students be placed in positions where they can have personal interactions with the material on their own terms. Such framing of the problem could then suggest instructional strategies such as periodic questioning. However, the data do indicate that factors such as goals and perceived affordances exert a considerable influence on Dr. Russell’s decision-making, which is consistent with prior research on instructional decision-making (e.g., Schoenfeld, 2000). Thus, beliefs appear to play an important, yet by no means an exclusive, role in shaping the teaching behaviors of this instructor.

Among the other factors that impinge upon faculty decision-making processes, many are grounded in the fact that features of the instructional task, such as the subject matter being taught on a given day or the aptitude of a group of students, play a role in shaping how faculty plan and then teach their courses (Eley, 2006). Some insights into these issues are suggested by the potential influence of disciplinary affiliation and the subject matter on respondents in this study. For example, Dr. Russell’s use of demonstration equipment (i.e., a pendulum hanging from the ceiling) was directly informed by the class’s chosen topic of the harmonic oscillator equation. However, it should be noted that the belief most closely related to the use of demonstrations (i.e., visualizations), was not shared by the other physicists in the study sample. Thus, while in this particular case the data are insufficient to indicate whether disciplinary affiliation and the subject matter are significant factors in shaping teaching practice, they do suggest that the nature of the subject matter plays a role in determining how teaching-related problems are conceptualized and then enacted in the classroom.

**Implications for Instructional Improvement at the Postsecondary Level**

This study has implications for how policymakers, faculty developers, and education researchers approach instructional improvement at the postsecondary level. I suggest that faculty development initiatives focused exclusively on supporting faculty to adopt student-centered beliefs are unsupported by empirical research (Devlin, 2006). This is not to say that teacher thinking is inconsequential in regards to classroom practice and should not be addressed within the context of professional development. However, given the lack
of evidence regarding the causal relations among faculty beliefs, teaching, and student outcomes, faculty developers would be well served to not focus solely on faculty beliefs but instead to adopt a more comprehensive view of teacher growth and development. Such a view focuses on facilitating growth not only in beliefs about teaching and learning, but also in teachers’ abilities in curriculum design, instructional technology, and aligning content to appropriate pedagogy. Further, these abilities are best conveyed in a fashion where their application to the instructional contexts in which faculty work on a daily basis are readily apparent (e.g., Clarke & Hollingsworth, 2002). As Eley (2006) suggests, “If we want a teacher to behave in specific, more ‘student oriented’ way in a particular context, then we need to arrange for that teacher to practice those specific ways in that particular context” (p. 211). Promising examples of such an approach exist in programs that aim to deepen the pedagogical skills of faculty while also addressing the constraints and affordances that are present in particular institutions, departments, and classrooms (Saroyan & Amundsen, 2001).

The data reported in this article also hold implications for organizational leaders and others engaged in instructional reform. Another argument against the singular promotion of student-centered beliefs is the potential of such approaches to have the unanticipated effect of fostering faculty resistance to educational improvement initiatives. By coming into local colleges and universities with a priori assumptions about matters such as effective curriculum, the sources of poor educational outcomes (e.g., the faculty) or the superiority of student-centered beliefs, reform advocates may be fostering resentment among faculty who feel as if their experiences and perspectives are being ignored (Henderson & Dancy, 2008). In particular, given that an important and pervasive belief focuses on the notion that student learning is largely dependent upon their own hard work and practice, policy statements and reform initiatives that focus exclusively on faculty behaviors as the primary cause of student outcomes should at the very least acknowledge the role of student study habits in determining their own success or failure.

This suggestion is based in part on evidence that what some perceive as resistance is not just a belligerent reaction against change but may be a principled response to policies that are viewed as detrimental or inadequately sensitive to local practice, cultural norms, and organizational operations (Piderit, 2000). Similarly, research on reform implementation in the K-12 sector demonstrates that policies are interpreted, adopted or rejected, and adapted largely based on the cognitive frameworks of teachers (Spillane, Reiser, & Reimer, 2002). Thus, designing pedagogical improvement initiatives that pay close attention to local conditions and the belief systems of those who are the primary target of reform efforts may increase the chances that a new policy or innovation will be accepted (Cobb, Zhao, & Dean, 2009).
For example, the data reported in this paper suggest that, for the faculty in the study sample, the combination of beliefs regarding repeated practice and learning styles, features of specific courses (e.g., class size, available resources) and prior experience with the course may act in concert to frame how the instructional task is conceptualized and then “solved.” Using this information, educational leaders can then design programs that acknowledge and address these core aspects of local decision-making by tailoring new policies or innovations to these local realities. In other words, it is possible that this constellation of beliefs, perceived affordances and prior experience constitute the lens through which new policies will be viewed, and the success or failure of the intervention may reside in how well it is aligned with these local cultural norms and practices (Spillane, Halverson, & Diamond, 2001).

**Conclusions**

Based on the findings presented in this article, fruitful avenues for future research that address the relationship among cognition, context, and practice are apparent. First, future research should explore in greater detail how beliefs may act as a framing device for postsecondary teachers in naturalistic settings. Second, research focusing on how beliefs may influence practice through unconscious or automatic mechanisms should be conducted, largely due to increasing evidence that much of human action is determined by processes outside of conscious awareness (Feldon, 2007).

Finally, research examining the role of factors known to influence postsecondary teaching, (e.g., appointment type, disciplinary affiliation, and institution type) in how faculty construct the instructional problem space would shed important light on the role of individual characteristics and contextual factors on faculty cognition and action. In any case, a more multi-dimensional and nuanced approach to the study of faculty teaching is warranted, and promises to shed light on critical issues related to educational improvement at the postsecondary level.

**References**


