A SCIENCE FACULTY MOTIVATION ANALYSIS TO ADOPT EVIDENCE-BASED TEACHING

by

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CHAPTER I: INTRODUCTION

Every day students are sitting in undergraduate science classrooms and not uttering a word but only listening as their instructor delivers (Eagan, 2016; Tanner, 2009). This form of passive learning positions students as vessels for receiving content and misses the opportunity to construct more in-depth knowledge (Lefrancois, 2012; Cobb, 1994). The evidence-based teaching approach of using a student-centered class is far more engaging and supportive of deep learning (Michel, Cater, & Varela, 2009; MacDonald & Frank, 2016). Research strongly suggests that a student-centered approach that utilizes active learning improves student thinking, writing, and content retention (Bonwell & Eison, 1991; McKeachie, 1972; Felder et al., 2002). Many student-centered approaches have emphasized reducing the instructors' voice in the classroom and improved student cognitive outcomes within a class (Michel, Cater, & Varela, 2009). A course design focused on student voice would increase student learning because there would be opportunities for students to verbalize their understanding (Lefrancois, 2012).

Student voice is defined as any student spoken language utilized by them for learning or by instructors for assessing student knowledge (Tanner, 2009). The broad question becomes, "why the silence?" What motivates undergraduate science instructors to emphasize their voice over that of their students? Understanding and measuring the link between student voice in the undergraduate science classroom and faculty motivation to bring student voices to the forefront of learning is needed. This study used the Expectancy-Value Theory (EVT) as an analytical framework to understand the research-to-practice gap for using evidence-based teaching that increases student voice in undergraduate science education.

Undergraduate Science Student Voice – Are Students Talking?

While there is a movement towards the use of evidence-based teaching in undergraduate science classrooms, the research is clear that traditional lecture remains the dominant model (Mazur, 2009; Kevin Eagan, 2016). It is not uncommon for undergraduate science faculty to deliver content for the full class period with a scattering of questions to the students that are answered by just a few or quickly answered by the instructor (Silverthorn, 2006). The lecture model allows very little room for student voice in undergraduate science classrooms (Tanner, 2009). If a student voice remains a critical means for students to negotiate their understanding and for instructors to formatively assess their student learning, why is student voice not prioritized?

A large body of research has shown the importance of utilizing student voice in class to improve engagement and learning (Cook- Sather, 2006, 2007; Rudduck & Fielding, 2006; Rudduck & Flutter, 2000, 2004). The minimal implementation of evidence-based teaching in universities and colleges in the United States and thus minimal instances of prioritizing student voice could stem from faculty's differing views about how learning occurs with students. Faculty views may rest in a transmissionist view that learning best occurs through the transfer of knowledge using traditional lecture, a teacher-centered pedagogical practice (Pampaka & Williams, 2016). Pampaka and Williams (2016) found that students perceived a transmissionist approach as negating of student learning. Within a transmissionist view of learning, there is little time for contemplation when students are only taking notes and there is a lack of focus on group learning. This does not suggest that learning only occurs in group work because learning can occur in many ways. Learning can be situated in different contexts that give students

opportunities for engagement and deeper conceptual understanding (Greeno, 2006; Kolodner, 2006). Piaget described the mind as being *within* an individual, and that learning occurs through contemplation (Lefrancois, 2012). In contrast, Vygotsky described learning as a social endeavor with the collective *mind* of a group as the location where learning occurs (Lefrancois, 2012). Another possible hypothesis is that undergraduate faculty may believe that learning is social (a Vygotskian-like perspective) but should happen outside the "lecture" versus inside the classroom.

Also, a diversity of theories held by faculty may have created alternative conceptions on the importance of classroom student voice. As the educational movement continues towards evidence-based teaching, the problem is that faculty, particularly science, technology, engineering, and math (STEM) faculty, continue to stay with a teacher-centered approach versus a student-centered approach (Hurtado, Eagan, Pryor, Whang, & Tran, 2012). This study looked at undergraduate faculty's explanations for the research-to-practice gap. With a focus on increasing student voice as a critical component of almost all evidence-based practices, this research study explored faculty motivations to use evidence-based teaching. To understand this problem, faculty motivations were explored through multiple data sources: surveys, interviews, artifacts, and classroom voice data recordings. The cultural norms of each department case were also explored, and this next section explains the reasoning for including context in this study.

Understanding Faculty Cultural Norms Towards Teaching

There is a lack of student voice in many undergraduate science classrooms, and it is essential to take a more comprehensive view and address academic norms as enacted through faculty training, hiring practices, and reward structures. There is no educational

certification or pedagogical training requirements for higher education instruction. This idea of a student voice might feel foreign to faculty, and it is important to note this phenomenon. In participation recruitment, this study focused on faculty who have some interaction with science education research as an idea, because it is not equitable to only focus on participants who have no awareness about science education research and evidence-based teaching. One will not know as much about microbiology as well as a microbiologist does, so it is unrealistic to expect that research-focused faculty should know everything about science education research. However, it is essential to talk about the standards for science faculty teaching and hiring but also note that the focus of this research is on motivation.

Undergraduate science faculty are often hired with no training in teaching, pedagogical practices, and with little post-hire teaching support (Sunal et al., 2001). Potential tenure-track faculty candidates are often primarily evaluated by their research, publications, and funds raised, leaving them little incentive to better their teaching (Tanner & Allen, 2006). Brownwell and Tanner (2012) describe the academic barriers to adopting evidence-based teaching as the "big three," training, time, and incentives. Training, time, and incentives are necessary for the implementation of evidence-based teaching. However, they are not sufficient as professional identity, and faculty motivation may also play a role in the implementation of these normative structures to support teaching (Brownwell & Tanner, 2012). Many internal and external barriers exist within the higher education science culture, but this study is focused on faculty motivation.

This culture of de-prioritizing teaching often begins from the very onset of the interview process when a candidate is required to provide minimal or no evidence of

effective teaching. Some hiring processes do require a candidate to provide a teaching demonstration, but Tanner and Allen (2006) argue this process is screening for "gross inadequacies, rather than looking for stellar innovations or pedagogical skills" (pg. 1). During the interview process, the faculty's theoretical perspective, pedagogical practice, or classroom strategies are rarely discussed (Russell, Fairweather, & Zimbler, 1991; Caplow & McGee, 2001). The interview is often focused on perceived prestige through grants awarded and research publications (Caplow & McGee, 2001). This leaves little exploration of the use of research in teaching with prospective faculty participants (Handelsman et al., 2004; Tanner, 2009).

Science education research is believed to be in a post-active learning phase, meaning that active learning is more widely accepted and established (Dolan, 2015; Freeman et al., 2014). Given all the data to support evidence-based teaching in undergraduate learning, the field of science education is entering into a science 2.0 era (Dolan, 2015). Science education research has moved on to more engaging evidence-based teaching practices, but science-research-focused faculty have continued to use traditional lecture as the primary teaching strategy (Dolan, 2015). The evidence seems clear that evidence-based teaching strategies are more supportive of student content and effective learning than a traditional lecture. Why would undergraduate science faculty continue with less effective practices? Given the focus on STEM research, are faculty weighing the cost and benefits of evidence-based teaching in their classrooms? What are the faculty motivational barriers preventing this movement towards a student-centered classroom with more student voice?

Research Questions:

1. *Are students talking in these department case classrooms and how do the case's classrooms compare in terms of student classroom talk?*
2. *What motivational components influence science faculty in two department cases to adopt evidence-based teaching and use student voice in the classroom?*
3. *What situational conditions support science faculty motivations for focusing on teaching practices based on evidence?*
4. *What do science faculty members perceive would have to change in their department or within themselves to adopt evidence-based teaching that prioritizes students' voices?*

Organization of the Dissertation

Chapter II will explain the theoretical grounding of evidence-based teaching, explore the current landscape of evidence-based teaching implementation in context, and introduce the Perspective, Practice, Strategy, and Product Learning Model (PPSP). The PPSP model explains the researcher's theoretical perspective. Chapter III describes the study's methods. Chapter IV is the results organized by the research questions and evidence. Chapter V was organized around the findings in Chapter IV and discussing the implications of this study.

CHAPTER II: REVIEW OF LITERATURE

Introduction

To understand the research-to-practice gap and address the research questions, this study focused on faculty motivation. Before moving on to the rationale for a focus on faculty motivation, it is important to lay out the researcher's theoretical perspective on teaching and learning and how that informs the research perspective. This theoretical perspective is the author's view on the real-world complexities of education and teaching practice decision-making. A visual model called the Perspective, Practice, Strategy, and Product (PPSP) (Figure 2) had been created to provide context and understanding for the reader moving forward in how the researcher visualizes the critical components of instructional practice. The model is somewhat hierarchical and begins with the broadest category, "perspective." The *perspective* is the way the author conceptualizes learning and is rooted in constructivism. The *practice* is the broad teaching practice used to inform the strategies influenced by the teaching perspective. *Strategies* are the categories of activities created when designing a course to achieve the learning objectives of each topic or chapter. Finally, the *product* is the desired outcome of learning strategies and in this case, an increase in student voice, engagement, and deeper conceptual learning. Chapter 2 begins with laying out each part of the PPSP theoretical perspective in more detail which is based solely on the author's theoretical perspective about science education and learning. The goal is to acknowledge that researcher bias can exist in the analysis of qualitative data when using the researcher as an instrument, and the author must explain the research lens being used.

The PPSP perspective is modified from the Instructional Decision to Enable Active Learning (IDEAL) theory from Arthurs and Kreager (2017) (Figure 1).

Figure 1. Instructional Decision to Enable Active Learning (IDEAL) theory from Arthurs and Kreager (2017, pg. 2084). The IDEAL theory describes a breakdown of the omnibus term "active learning" into active learning activity, active learning strategy, and active learning approach with arrows indicating the decision-making at each level of instructional decision making.

The IDEAL theory is focused on instructional decision-making to implement active learning. It is a research framework for categorizing responses from instructors who process questions on how and why they may implement active learning in their classrooms (Arthurs & Kreager, 2017) (Figure 1). The IDEAL theory is grounded in constructivism as is the PPSP theoretical perspective. However, the IDEAL theory does not clarify the results of decision-making (the *product* of education). The PPSP theoretical perspective aligns with the IDEAL theory's approach, but additionally, it extends the theory to include *practice*. IDEAL's strategy aligns with the strategies in the

PPSP perspective; however, PPSP's strategies and activities are placed in the same category. The PPSP theoretical perspective is different from the IDEAL theory because the result of evidence-based teaching, which is called the product, is implemented. The product of evidence-based teaching should be an increase in student voice and student learning. The PPSP differs, as well, by adding perspective as a critical characteristic to faculty instructional decision-making (Figure 2).

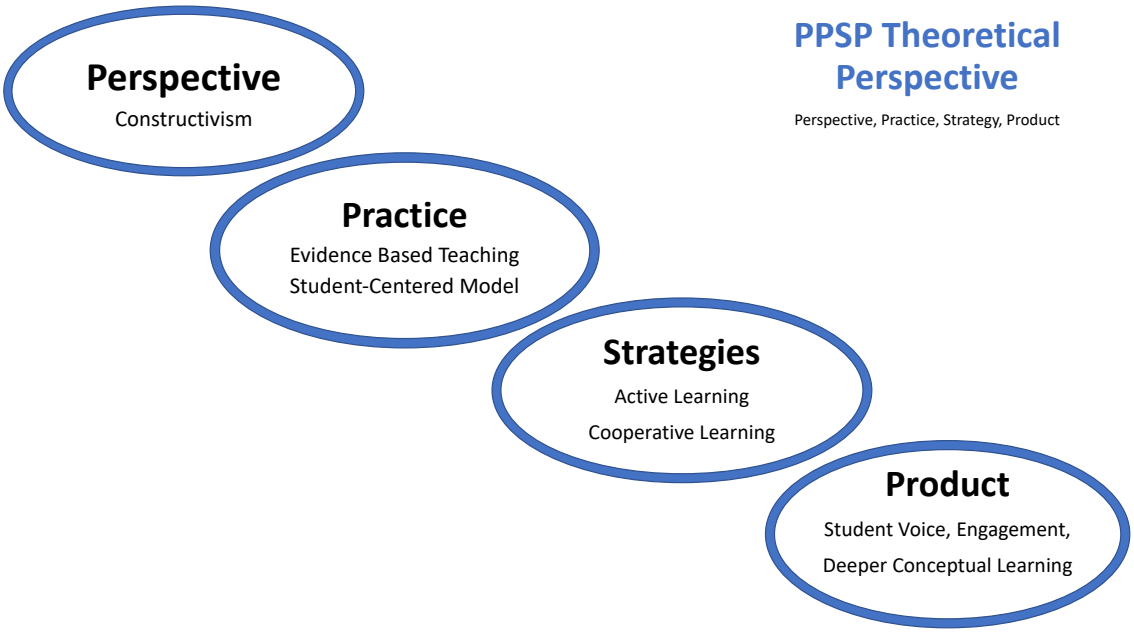


Figure 2. PPSP Theoretical Perspective.

A Constructivist's *Perspective*

Perspective is the way one thinks about a particular object or action and is often guided by experiences and beliefs (Collins, 2018). One's *perspective* can inform one about any given situation or environment. This interpretation of the world is the basic building block to the PPSP theoretical perspective.

Embedded in the PPSP theoretical perspective is the author's view on teaching and learning. The author's view is based on constructivist learning theory, considered the most current science education learning perspective. Constructivism posits that previous knowledge informs the construction of new knowledge (Cobb, 1994). The constructivist perspective assumes that people build new learning onto prior knowledge and that meaning-making comes not from giving the answers to students but letting them construct their answers (Lefrancois, 2012). Science learning has wider accessibility and is more engaging through a constructivist perspective that considers the social and cognitive aspects of learning (White & Fredricksen, 1998). Learning is built upon students' prior knowledge by altering their existing mental models (Alexander, 1996).

The author's perspective for learning is that students thrive when science faculty facilitate learning from a constructivist perspective, building upon prior experiences and ideas. This understanding of how students best construct knowledge is foundational to a student-centered teaching model.

Evidence-based teaching and student-centered *model*

The word *practice* is referencing an individual's teaching approach and how that conventional teaching approach informs the class experience and course design (Collins, 2018). The practices referenced in this dissertation are directly rooted in the theoretical perspective of constructivism and align with Grossman et al. (2009), who said one's practice is relational. A relational practice refers to the idea that when working with novices or students it is important to establish relationships with them when preparing for the professional world (Grossman et al., 2009). Practices that are under a constructivist perspective are evidence-based, believing that knowledge is constructed and informed by

what the literature defines as effective teaching approaches. One's theoretical perspective informs practices, and under the evidence-based teaching umbrella, a student-centered model naturally fits because the model is social, engaging, and relational.

A student-centered model best suits the use of active learning and an increase in student voice because of the required level of interaction. In a student-centered model, the teacher is less "sage on the stage" and more "guide on the side" with a change in the traditional roles of teacher and student (Weimer, 2002). Traditional lecture is used at the undergraduate level even though faculty have been urged to use a constructivist student-centered model (Bransford, 2000; Mazur, 2009; Kevin Eagan, 2016). The student-centered model reflects the constructivist belief that students are not merely empty vessels needing to be filled, but that students should have the opportunity to construct knowledge (Lefrancois, 2012). Undergraduate science education needs a paradigm shift, a movement from teacher-centered learning towards a student-centered model of learning (Barr & Tagg, 1995; Mazur, 2009; Kevin Eagan, 2016). This paradigm shift requires the use of more engaging strategies and an understanding of faculty motivation to support the engagement of the research-to-practice cycle of higher education teaching. What are engaging strategies for learning?

Active learning *strategies*

Within one's teaching approach, the course design is implemented each semester. The PPSP model suggests that the course design should set out to achieve a set of learning objectives. The course *strategies* and activities should align with the content to best achieve those learning objectives. All the activities that make up the course design should be informed by a teacher's perspective and practice, and define the course

learning strategies (Collins, 2018). Based on the research, active learning strategies are the best for engaging and supporting a student-centered approach in the classroom. When activities provide student's opportunities to engage with content by providing moments to explore, verbalize, or struggle with content, this is active learning (Bonwell & Eison, 1991). Active learning strategies create experiences where students are "doing science" more than simply taking notes (Felder & Brent, 2009). Active learning has students talking, engaging, and thinking about content with their peers. Active learning strategies can take as little as five minutes and can be easily integrated into large classrooms (MacGregor et al., 2000; Allen & Tanner, 2005). One of the most straightforward active learning strategies is creating a period of structured questioning and eliciting student responses (Felder, 1997). This creates an opportunity to explore student alternative conceptions and build upon students' prior experiences and knowledge. This strategy is more collaborative and engaging than traditional lecture.

There are other terms similar to active learning such as collaborative learning, cooperative learning, and problem-based learning (PBL). The use of the phrase "active learning" was intended to mean all of these activities and strategies as well. However, no matter the term used, the shift from a teacher-centered model to a student-centered model requires the use of more engaging strategies that one finds in active learning. Why is this approach preferable?

Why Active Learning?

The leading education organizations all agree that active learning strategies are useful, and they encourage science educators to adopt these strategies because they help connect abstract concepts with real-world applications (National Science Foundation,

1996; National Research Council, 2003; American Association for the Advancement of Science, 2011). The data support fostering a student-centered model to address American undergraduates being left behind in science fields (Center for Science, Mathematics, & Engineering Education, 1999; The White House, 2009). The current teaching practices are missing engagement (interaction with peers and instructor about content), which is valuable to student's conceptual learning.

This current generation (millennial and post-millennial) of students has engagement 24/7 and demands engagement when learning, hence the value of active learning strategies in the classroom. It used to be that books were rare, and a professor was the primary source of knowledge (Silverthorn, 2006). This is not the case today where students can turn to Google or Wikipedia. Students no longer depend on professors for information acquisition (Silverthorn, 2006). Active learning does not just give students information but provides opportunities to analyze and navigate information. Students have access to information any time they want with their smartphones (Silverthorn, 2006). However, students can benefit from a content specialist facilitating the exploration of new information, sharing ideas, and making connections (Henderson, Nunez-Rodriguez, Casari, 2011). Students have access to information on the internet, but students need experts to help engage them in using their voice for rich learning opportunities. Active learning improves the quality of student learning and supports student retention (Bonwell & Eison, 1991; McKeachie, 1972; Felder et al., 2002).

Active learning keeps students involved, and involvement is a crucial predictor of college degree completion (Astin, 1993). To be successful in college, students must pass many exams, and student exam performance has been linked to the use of active learning

strategies in science courses (Hake, 1998). Laws et al. (1999) demonstrated significant higher conceptual understanding among students in a classroom using active learning versus traditional lecture. It is plausible that active learning can be used to work with what is understood about student attention.

Student attention span can be as little as fifteen minutes (Wankat, 2002). Active learning is key to addressing the attention span issues (Prince, 2004). Once student attention wanes, content retention drops drastically after that, with students remembering 70 percent of the first ten minutes of lecture and only 20 percent of the last portion of lecture (Hartley & Davies, 1978). Active learning strategies give students an attention break and create an opportunity to bring them back to the start of that attention span countdown. In a world with increasing distractions, active learning could be crucial to engagement and attention span issues. Thus, a move from students not talking to students playing a more active role in the classroom is paramount for student learning.

The *Product* of Student Voice in the Classroom

Students should be talking and learning through social interaction because science itself is a practice that profoundly involves language exchange and social skills (Hall-Kenyon & Smith, 2013). The literature demonstrates that there is a lack of student voice in undergraduate classrooms (Tanner, 2009). Perhaps, that is due to the faculty's theoretical perspective on learning but also could be due to where faculty believe learning occurs.

Faculty who adopt evidence-based teaching would ideally see, as a *product*, an increase in student voice. It is essential to clarify what is meant by a student voice. For clarity, student voice is not students asking questions about non-content talk. Student

voice is any spoken language applied by students or teachers for learning or evaluating student knowledge (Tanner, 2009). Student voice is not merely any time students are talking in the classroom. For example, a student asking about the time and length of an exam is not a student voice. Student learning is the product of student voice and students constructing knowledge.

Often undergraduate science faculty control the classroom voice dynamic (Boyd & Rubin, 2006). If students are talking, it is often more of a procedural call and response (Chin, 2006). Boyd and Rubin (2006) showed the best way to move students from regurgitating facts was to incorporate authentic student voice into the classroom by utilization of previous student comments. In the classroom, this would look like a move from the Initiate-Response-Evaluate (IRE) model of questioning to a student voice model that uses student language to facilitate learning. This is further supported by Smith et al. (2009) who showed that effective active learning in the classroom requires student voice to increase conceptual learning. There are many strategies to increase student voice, and the literature has a whole body of work devoted to highly effective questioning strategies that align with increasing student voice (Chin, 2004, 2006; Cotton, 1998; Beatty et al., 2006).

Teachers should understand that student voice is vital for learning and requires effective questioning strategies. However, there is an apparent gap in faculty intention, decision-making, and the reality of classroom practice. Is it possible faculty motivation to use evidence-based teaching and student voice is connected? There are three significant influences on understanding the research-to-practice gap, and the next section describes how this study focused on only one influence, faculty motivation (Finelli et al., 2014).

The following section outlines how this study narrowed its focus on faculty motivation and the choice of the Expectancy-Value Theory (EVT) as an analytical framework.

Influences on Faculty Instructional Change

Faculty Behavioral Influences

The study's rationale is built upon the three major influences of faculty behavior from Finelli et al. (2014) (Figure 3). What influences higher education faculty behavior? Finelli et al. (2014) described those as organizational change, instructional development, and faculty motivation (Figure 3). Potentially, the combination of these three influences impacts the research-to-practice gap, but it would be difficult to focus on all three in one study. In the literature review, it became clear that there is little research on higher education science faculty's specific motivators for teaching practice decision making. This study was not capable of addressing all three of these areas; therefore, the focus was narrowed to faculty motivation. Faculty motivation research is vital because, in order for university strategic planning to succeed, it must create faculty buy-in (Henderson et al., 2011; Browne, 2005). Further research on faculty motivation could foster quality conversations with faculty to impact change in the research-to-practice gap (Graham, 2012).

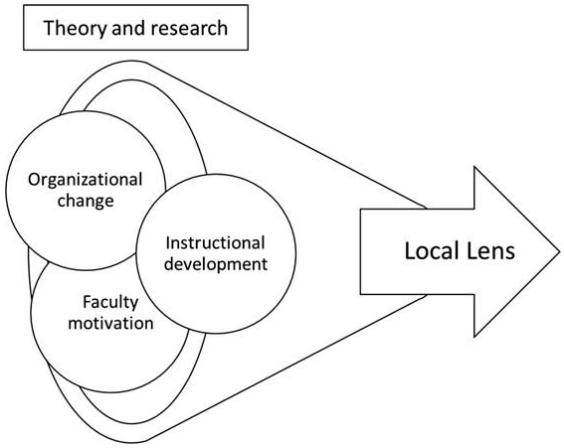


Figure 3. Finelli et al (2014) Figure pg. 333.

The focus of this research was to understand the motivational barriers to faculty adopting evidence-based teaching. Evidence-based teaching requires students talking, and therefore, by its nature increasing student voice is deeply steeped in the literature but could be viewed as an assumption of this study. A second assumption guiding this study was that classroom voice might influence using evidence-based teaching. Both student and faculty voice are vital for facilitating learning. To understand this second assumption, below is an excerpt from Finelli et al. (2013) (pg. 11) that looked at faculty motivation and how it affected teaching practices.

> *"It's partly a role thing, you know—you have a particular role with the students when you're primarily a lecturer, the kind of, you know, wise person dispensing knowledge, and when you get away from that, you're really changing your sense of who you are in the classroom, it feels like, you know, and that's not an easy… it's kind of threatening..." (pg. 11).*

Many factors including motivation are influencing the faculty motivation in this excerpt and those influences will be specified in another section. Though the focus was on faculty motivation, it is essential to give some context on the significant work of the other two

influences, organizational change, and instructional development. The following section gives a very brief overview of the scholarship on these components.

Organizational Change

Organizational structure and policies can significantly influence the teaching practices of undergraduate science faculty. Henderson and Dancy (2007) stated it best saying, "It is important that the educational research community begin to unravel the nature of these political and institutional structures that influence the landscape of educational change" (pg. 12). Higher education can address this lack of evidence-based teaching in the undergraduate classroom by understanding those barriers and developing plans to overcome them (Henderson & Dancy, 2007; Beach, Henderson, & Finkelstein, 2012).

They further described change categories for curriculum and pedagogy, reflective teachers, policy, and a shared vision (Beach et al., 2012). Undergraduate institutional strategic planning typically begins by attempting to tackle one or two of these categories and is successful when institutions engage undergraduate faculty directly (Henderson et al., 2011). This makes sense because studies show that evidence-based teaching adoption requires buy-in at the organizational level as well as the faculty level (Browne, 2005).

Institutional change requires a vision that considers the input of faculty and fosters a common purpose, such as increased student talk and learning (Graham, 2012). Though the perfect strategic organizational change plan would focus on all three influences described in Finelli et al. (2014), this type of study would require extensive time and funding. While the focus was on faculty motivation, data were collected that describes the teaching perspectives and policies set through universities' tenure

guidelines. Before moving on to faculty motivation, the influence of professional development was considered for its role in evidence-based teaching adoption.

Professional Development

Professional development is any interpersonal training devoted to fostering job growth and performance. Professional development can take on many forms, and moreover, is a tool for implementing some organizational change and harnessing faculty motivational strategies. Some argue that higher education professional development (PD) makes a minimal long-term impact on teaching practices (Gibbs & Coffey, 2000). Once a faculty PD plan is implemented, it is often rare that faculty implement strategies as intended and relapse to old habits of more traditional instruction (Brownwell & Tanner, 2012). Dancy and Henderson (2010) did a large-scale faculty survey and found that faculty often modified evidence-based teaching strategies. Finelli et al. (2014) designed a change plan with a focus on instructional development and evidence-based teaching acceptance, and data suggest both parts were successful. The Finelli et al. (2014) study used localized institutional data to drive a change plan for improving the research-to-practice gap and required organizational strategic planning. Often these localized pedagogy change efforts were limited to specific institutional or departmental contexts (Grunspan, Kline, & Brownell, 2018). Maintaining lasting change with individuals who move on to new institutional cultures is complex, and often that faculty adopts the institutional culture (Martin & Dowson, 2009). Because cultures are complex, this study investigated faculty motivation in two departments. This study focused on gaining insight into faculty motivation to understand the adoption of evidence-based teaching and inform future PD plans.

Defining Motivation

Faculty motivation research is important because of its relatedness to other undergraduate classroom variables such as teaching practice, student motivation, and higher education reform (Han & Yin, 2016). What is faculty motivation? Motivation is a broad construct and has been defined in many ways, so following a brief exploration of the history of the definition of motivation, it was operationalized for this study. The when, what, and how one learns can influence motivation (Schunk & Zimmerman, 2008). Cognitive Expectancy-Value Theory defines motivation as a function of the expected value, goal, or incentive to be gained through successful behavior performance (McKeachie, 1997). The expected value and goal of this definition aligns with the Expectancy-Value Theory that will be later discussed as the fundamental analytical framework for this work. Deci and Ryan (1980) have a slightly different take on motivation, assuming that the completion of activity alone can influence internal and external motivators and provide personal satisfaction. Satisfaction is a component of motivation and explored as the interest value in the Expectancy-Value Theory. Within motivation, influencing factors can be divided into internal and external motivators (Matusovich et al., 2014).

Motivation is defined by Schunk et al. (2014) as a process that is started and lasting due to one's activity-driven goals. Lasting was a keyword and was one of the reasons to look at motivation, because even after professional development, faculty have a tendency to revert to previous teaching practices (Gibbs & Coffey, 2000; Dancy and Henderson, 2010; Brownwell & Tanner, 2012; Hurtado et al., 2012). Hurtado et al. (2012) argued that STEM faculty fields had used teacher-centered approaches, relying

heavily on lecture, more often than peers in other disciplines. People embrace change through ownership of change and change can be a long slow process (Ford & Ford, 1995). Implementation of evidence-based teaching requires a long term iterative process, incentives, and PD and this study explored motivation to support a permanent shift towards evidence-based teaching (Keagan, 2016; Brownwell & Tanner, 2012).

For this study, all of these definitions were taken into account. Motivation for this study was defined as a series of factors influenced by the when, what, how, and satisfaction that is often incentivized by achieving a lasting goal or expected value. However, this research recognized the other significant part of the motivation, external motivation and understood its influence in the research-to-practice gap. Specifically, this study analyzed achieving tenure and how that influences the motivation by individual faculty members. To further understand this association, external motivation was considered when looking at tenure policy data and will be explored in the next section.

External Motivation

Behavior, beliefs, and values are all influenced by internal and external motivation factors (Eccles, 2009; Schunk, Pintrich, & Meece, 2008). Individuals construct social meaning through their interpretations of events and experiences (Matusovich et al., 2014). External motivation can include a faculty's perceptions of what higher education institutional stakeholders believe, what universities believe, the perception of roles, and the collective norms of an institution (Matusovich et al., 2014). This research took into account that external motivation is a factor in the research-to-practice gap (Figure 4).

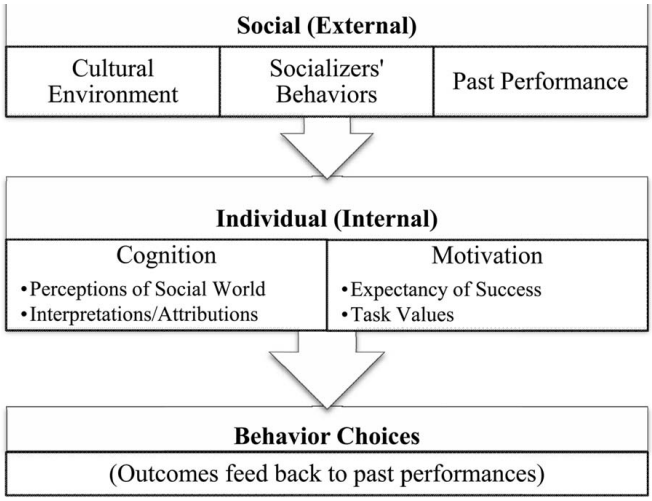


Figure 4. Matusovich et al. (2014, pg. 309) Tenets of EVT situated in the context.

While the individual perspective is the study's focus, as shown in Figure 4 the approach also includes interpretations of the social system in which the individual acts. Concerning engagement in a research–practice cycle in engineering education, this social system includes local departmental contexts as well as the field as a whole. Expectancy-Value Theory and other motivation theories are grounded in the idea that faculty motivation, including values and beliefs, are influenced socially (Matusovich et al., 2014). Being social teaches faculty how to fit in with a particular faculty group; because faculty learn what values and beliefs are acceptable within their departments (Martin & Dowson, 2009). This is common within any company or organization where new employees spend time relationship building and learning employment culture and norms (Awadh & Saad, 2013). Martin and Dowson (2009) argued that one is socially motivated to be connected to others and defined that as "relatedness." Interestingly, relatedness and autonomy are critical characteristics of motivation in Self-Determination Theory (SDT) and connected because of the importance of individual and relational

needs (Angyal, 1941, 1965; Bakan, 1966). Matusovich et al. (2014) emphasized this same point; that it is easier to understand individual motivation versus understanding institutional systems. Investigating organizational change requires more strategic planning and moving components. Working one-on-one with faculty to understand motivation was designed to help create long-lasting, effective change. This assumption was one of many factors driving this study to focus on faculty motivation.

Internal Motivation

Internal motivation is the most significant influence on the positive potential of human beings (Ryan & Deci, 2000). Individual motivation is a crucial component of organizational change (Matusovich et al., 2014). If the critical component of motivation drives organizational change, what are the key factors to this type of motivation? Stupnisky et al. (2017) argues that internal motivation is satisfied by three needs: autonomy (self-regulated), relatedness (connection to others), and competence (ability to complete tasks). It is possible that internal motivators are the real driver of behavior, and when these needs are not met, faculty are influenced by external motivation (Stupnisky et al., 2017). Internal motivation is a driving reason for one study interview question related to removing external barriers. If all external barriers are removed and all faculty needs were met, the question asked what would faculty teaching practices look like. Martin and Dowson (2009) suggested that individuals are at the heart of most motivation theories and that the influence of individuals in a specific context should be considered. Besides motivation, there is an understanding that social and organizational factors affect the research-to-practice gap. Because of this, contextual data from the department cases'

potential social and organizational factors were collected to help understand the faculty motivators.

Self-identity and Motivation

This study also considered self-identity as a motivation factor because it could explain part of higher education science faculty's intention to use evidence-based teaching (Zint, 2002). Identity is other people's recognition of one as a type of person in a given context (Hacking, 1983, 1986, 1994, 1995, 1998; Gee, 2001). There are many ways to define identity but this study defined it in the context of work known as "professional identity." In this study, professional identity of faculty members was narrowly defined as focused on the self-identification of faculty as a researcher, teacher, or both. However, identity is not fixed, and this idea was factored into research questions about faculty identity (Mead, 1934; Erikson, 1968). During the interview, the researcher made sure to probe if participants identity had evolved and if so how. For example, some participants identified early in their careers as researcher but later in their career identified as both or more with the identity of teacher. This study looked at many motivational moderators including how participants identified on a continuum of researcher to teacher.

Many studies have focused on faculty needs such as time, training and incentives with professional identity being ignored as a motivational moderator (Brownell & Tanner, 2012). It is vital to consider self-identity because the Expectancy-Value Theory's attainment value component is the importance of being successful on a task (Eccles et al., 1983; Wigfield & Eccles, 2000). The value placed on an activity should be congruent with one's needs, values, and identity (Stupinsky et al., 2018). Therefore, faculty professional identity was explored in this study because of its placement in Expectancy-

Value Theory. However, other motivation theories were also considered for this analysis and are discussed in the next section.

Internal Motivation Theories

Many internal motivation theories exist, such as Bandura's Social Cognitive Theory that looked at self-efficacy, Self-Determination Theory, and Effectance Motivation Theory (Bandura, 1997; Ryan & Deci, 2002; White, 1959). Some of those theories were explored before settling on the Expectancy-Value Theory (EVT). To understand the author's selection of EVT, the following section will outline a brief exploration of other common motivation theories and the author's rationale for exclusion of them. One of those theories deals with rational or irrational decision-making. This study looked at the decision making of individuals and therefore assumes that individuals are rational actors (Tversky & Kahneman, 1974), understanding that decision making can also fall into the heuristic realm. A heuristic is a mental shortcut humans use to make quick decisions. Heuristics understands that individuals create shortcuts for decision making after repeating the same decision over time and that there are errors in this type of decision-making (Tversky & Kahneman, 1974).

The assumption that individuals are rational actors was used to analyze the perceptions of costs and benefits that science faculty use to make teaching decisions. For this research, the Expectancy-Value Theory was used as a framework for analysis and under the assumption that the decisions analyzed are from a rational actor point of view. However, other motivation theories in higher education exist. It was important for this research to consider other motivation theories. Self-determination theory and effectance motivation theory often are cited in faculty motivation literature. Both theories are

established in the literature for supporting the understanding of faculty motivation and teaching practices and a brief description for each is provided below.

Self-Determination Theory

Self-Determination Theory (SDT) states that internal motivation is satisfied by three needs: autonomy (self-regulated), relatedness (connection to others), and competence (ability to complete tasks) (Schunk et al., 2014). SDT states that when humans' basic psychosocial needs are met people will likely be more motivated to use a said task such as evidence-based teaching (Deci & Ryan, 1985; Stupnisky et al., 2017). According to SDT, external motivators more easily influence faculty when these needs are left unmet (Stupnisky et al., 2017). SDT speculates that the needs of competence, autonomy, and relatedness may be related to concepts of achievement, power, and affiliation needs (Atkinson, 1958; Winter et al., 1998).

Black and Deci (2000) used SDT to examine student self-regulation and the students' perceptions of instructor autonomy and found that instructor autonomy increased student self-regulation over a semester. If faculty members were more autonomous, then so were their students (Black & Deci, 2000). Sorebo et al. (2009) used SDT to explore external motivation for teacher use of e-learning technology and found that a teacher's psychological needs and internal motivation are predictive of using technology in the classroom. Overall, there is not an extensive history of research using SDT to specifically examine motivation with faculty who have not adopted evidence-based teaching. However, a code for autonomy was created because of SDT and used to explore transcripts using the Expectancy-Value Theory analytical framework.

Effectance Motivation Theory

Effectance motivation, sometimes called mastery motivation, is an internal drive to interact with one's environment and attempt to control it (Schunk et al., 2014). White (1959) coined the phrase effectance motivation and defined it as the feeling of efficacy one has that is motivated by competency. White (1959) believed that humans are driven by a need to interact with the environment in a way that is gratifying and gives one pleasure from accomplishments. The effectance motivation theory is steeped in heuristics, the concept of humans making decisions through mental shortcuts (Harter & Zigler, 1974).

The primary study that explored faculty motivation and the effectance motivation theory is by Tien (2000). Tien (2000) used the Expectancy-Value Theory and Effectance Motivation Theory to examine to what degree promotion motivation drives the quality of faculty research. This supported the idea of achieving tenure as a category used in the EVT analytical framework. Effectance Motivation Theory (EMT) is derived from early views of motivation and not widely used in modern science education research (Schunk et al., 2014). Theories like SDT and EMT were considered for this research, but the study has used the Expectancy-Value Theory because of its clear application for studying motivation.

Expectancy-Value Theory

According to EVT, individuals will engage in tasks they expect to be successful at and tasks that they value (Eccles et al., 1983; Wigfield & Eccles, 2000). The interaction (Figure 3, pg. 336) between one's expectancy to succeed and the value of tasks required to enact a particular behavior will determine if a person will take action (Finelli et al.,

2014). In this case, the action would be the adoption of evidence-based teaching and increased student voice. EVT can investigate the internal and social motivators that may be found in the data collection (Matsuovich et al., 2014). EVT has previously been used to investigate undergraduate faculty teaching practices (Matsuovich et al., 2014; Hixson, Paretti & Pembridge, 2012). What is the Expectancy-Value Theory? Schunk et al. (2014) described EVT as a way to use expectancies and values to predict an individual's potential choices, level of interest, and success of a task. The predictive nature of EVT was crucial for understanding how to factor faculty motivation into future professional development (Eccles, 2005; Eccles, 2009; Eccles et al., 1998; Wigfield & Eccles, 2000). EVT has a long history rooted in the theory of planned behavior (TPB) and the theory of reasoned action (TRA) (Ajzen, 1988).

The belief about one's abilities to perform a task successfully and the difficulty of that task are expectancies (Schunk et al., 2014). The reasons one might take on a task are the values of the EVT model (Schunk et al., 2014).

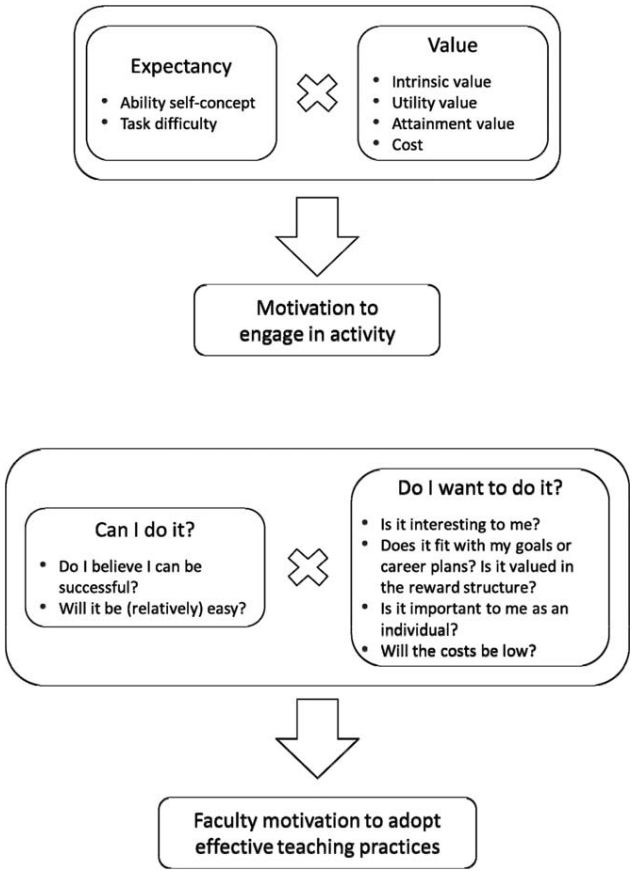


Figure 5. Finelli et al. (2014) The Expectancy-Value Theory of Motivation. The top part of the figure shows the standard Theory, and the bottom part shows Finelli et al. (2014) context-specific interpretation of the theory.

The value of time can be viewed as time lost in the classroom given the university set schedule parameters. Time lost could be devoted to other job tasks such as research or service for faculty. This study also explores the idea that the accuracy of the content delivered could be viewed as a cost to science undergraduate faculty. For the expectancy part of the model, this study investigates the ability of self-concept which will be defined from here on out as self-efficacy. Self-efficacy affects internal motivation because it is the belief in one's ability to successfully produce outcomes (Rutherford et al., 2017).

Rutherford et al. (2017) found that undergraduate mathematics faculty who valued professional development had a higher self-efficacy. An assumption could be made that faculty with higher confidence would be more interested in professional development, and those that have lower confidence may not be interested in evidence-based teaching or professional development. For this study, the EVT was used to understand those decision-making factors for adopting evidence-based teaching and increasing student voice.

Previous Studies using EVT with Faculty

There are three EVT focused papers that are critical to this study about faculty motivation: Rutherford et al. (2017), Finelli et al. (2014), and Matusovich et al. (2014). This research incorporates some of the coding from Finelli et al. (2014) and Matusovich et al. (2014), and it is essential to explain why and how this study built upon their work but is also innovative and novel.

Rutherford et al. (2017) used EVT to guide the creation of a professional development program. They looked at self-efficacy in using technology to enhance student achievement. They found that higher faculty self-efficacy had a positive influence on the achievement of the students in participants' classes. This study did not account for faculty not interested in implementing evidence-based teaching, and faculty who did not complete the professional development were excluded from the data. From this exclusion, one could assume that some faculty felt overly confident and did not feel they needed to change or adopt evidence-based teaching. These assumptions are anecdotal and demonstrate the complexity of faculty motivation to adopt evidence-based teaching and the need to explore motivations, values, self-efficacy, and the cost-benefit analyses that

go into decision-making around instructional practice. The following are some influential studies that were pivotal and informative to this study.

Finelli et al. (2014) focused on evidence-based teaching through institutional change plan analysis. They used faculty focus groups to investigate factors that influence evidence-based teaching. Through this work a plan for faculty and for the administration was developed which emphasizes the importance of local data in change plans. Finelli et al. (2014) focused on engineering faculty, whereas this research focuses on science faculty teaching practices in general. This study was different in the specific focus on faculty motivation in a different context.

Matusovich et al. (2014) interviewed and surveyed participants at two engineering conferences to better understand the lack of faculty engagement in the research-to-practice cycle. Through this work Matusovich et al. (2014) identified some important values such as the cost and utility value for implementing evidence-based teaching with faculty. Participants in this study were already interested in evidence-based teaching or were already implementing evidence-based teaching because both conferences were focused on engineering education. Much of the findings found external motivators for not adopting evidence-based teaching. This research was possible because of these studies working with EVT. This dissertation worked to extend the understanding of faculty motivation. Chapter III explains the methods for how this work was extended, the research questions, and how this study explored the connection between faculty motivation and evidence-based teaching.

CHAPTER III: METHODOLOGY

Introduction

Research questions on faculty motivation were investigated using a mixed methods research design. The research used interviews, surveys, artifacts, and classroom voice data to understand better the faculty motivation to use evidence-based teaching in higher education. The Expectancy-Value Theory was used as a framework for analyzing the data from two formal cases. The case unit of analysis was the biology departments, and the individuals were embedded units within each case. The goal of this research was to investigate faculty motivators to inform how to address the research-to-practice gap and any future professional development strategies.

Research questions:

1. *Are students talking in these department case classrooms and how do the case's classrooms compare in terms of student classroom talk?*
2. *What motivational components influence science faculty in two department cases to adopt evidence-based teaching and use student voice in the classroom?*
3. *What situational conditions support science faculty motivations for focusing on teaching practices based on evidence?*
4. *What do science faculty members perceive would have to change in their department or within themselves to adopt evidence-based teaching that prioritizes students' voices?*
5.

Research Design

A case study research design was used for this study because the goal was to understand the characteristics (motivations) to engage evidence-based teaching (Creswell, 2013). This case study design allowed for the analysis of the research questions in a bounded system, a department of biology and to compare it to another bounded system, a different department of biology (Creswell, 2013). This study used the QUAN–QUAL model (Gay, Mills, & Airasian, 2012) within the case study research design that equally used qualitative and quantitative data. Creswell (2013) described this research design as the concurrent triangulation design where data are analyzed concurrently in the collection process and later compared. This model allowed the study's data to be triangulated and the strengths and weaknesses of the quantitative and qualitative data to offset each other (Gay et al., 2012).

The QUAN-QUAL model was used in a case study research design. The research design of a case study used quantitative data from the survey to validate the climate patterns of each department case and a qualitative case-control approach allowing for each data type to inform the research questions in QUAN-QUAL model interaction (Creswell, 2013). This study analyzed two departments with the potential for different outcomes that were compared to identify any motivational factors related to the adoption of evidence-based teaching (Creswell, 2013).

These research questions required a research design using quantitative measurements and the use of thick descriptions through qualitative data collection. This research study provided a deeper understanding of faculty motivation from the individual perspective situated within a defined participant group (Tripathy & Tripathy, 2015). This

type of research design captured values, behaviors, and opinions in a specific context (Tripathy & Tripathy, 2015). To provide a robust and detailed account of faculty motivations, the researcher used triangulation between the interviews, surveys, artifacts, and classroom voice data. This gave context to the social environments of each department case.

In case study research, it is essential to define the case. The phenomenon of the research-to-practice gap was explored at two different sites, two departments at two nonrandom universities. This is referred to as a multi-case study that allowed the comparison of two cases (Creswell, 2013).

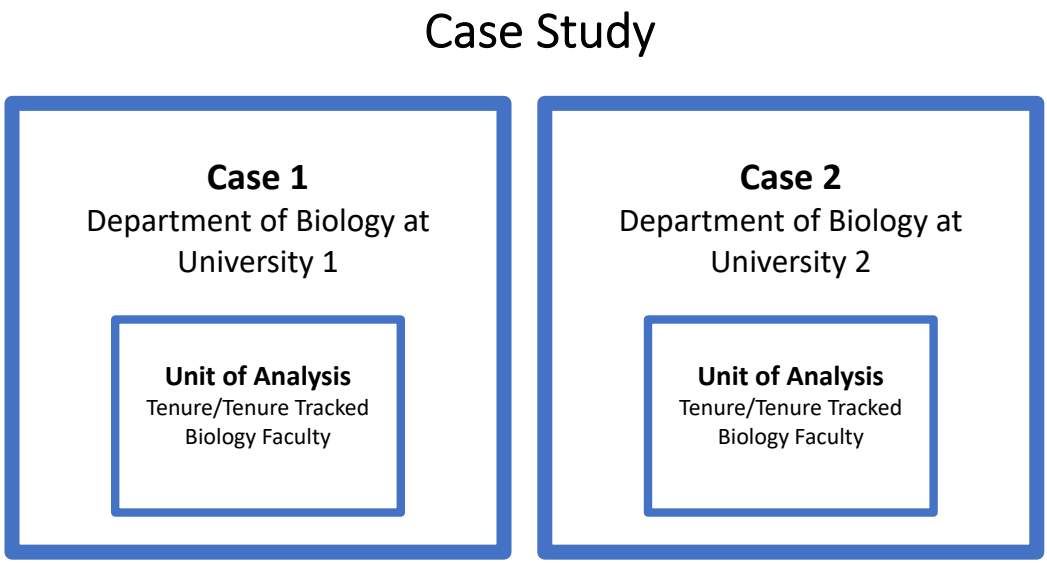


Figure 6. Type 4 Case Study Design (Yin, 2014, pg. 50) was used in a multi-case study analysis using faculty as the unit of analysis, embedded in each department case.

The focus of each case was tenure/tenure tracked biology faculty nested in two departments of biology (Figure 6). Case 1 did not have in place the same support structures for teaching as Case 2 and is described as moderately research activity focused according to the Carnegie classification (n=30). Case 2 was highly supportive of teaching being a faculty job focus and is described as having the highest research activity according to Carnegie classification (n=34).

Validity and Reliability of Qualitative Data Sources

This research intended to provide insight into faculty motivation to inform future professional development, not to provide statistical generalizability of a population. As such, this work followed Guba's criteria for the validity of qualitative research by establishing credibility, transferability, dependability, and confirmability (Mills & Gay, 2016). This study considered patterns that are complex and hard to explain requiring multiple data sources (credibility), and it was deeply rooted in the case study context and not overly generalizable (transferability). This work required triangulation and an established audit trail (dependability). Co-researchers were involved in the process of inter-rater reliability and had access to all of the raw data including transcriptions, audio recordings, and survey data in order to establish an audit trail.

Triangulation of interviews, surveys, artifacts, and classroom voice data allowed for dependability. Using multiple data sources and understanding the context of each case instilled credibility and transferability. To understand the context of each case, the research analysis was cyclical, drawing from the original theoretical perspective as an analytical lens, and considering how individuals are nested within their different contexts of each different department. However, it was important to have clear boundaries in case

study design between the phenomenon (faculty decision making and motivation) and the context (department) (Yin, 2014). Also, transferability of this research can only be applied to a similar context such as that of higher education faculty at institutions described below.

The researcher is aware of the bias with a "researcher as an instrument" and maintained objectivity (confirmability) through the data collection. The author has revealed in this dissertation any assumptions to ensure the confirmability of the data. To ensure the reliability of the qualitative data, a process of interrater reliability was used during the coding process using the EVT analytical framework. Researchers affiliated with this study scored data to ensure that data were coded consistently using the EVT analytical framework codes. The interview data were scored by three raters with a 91% agreement on the codes. Before this study is published, more data will be scored through an inter-rater reliability process.

The goal of this research was to provide data on motivators that require the researcher to make transferability judgments for the dependable application (Lincoln & Guba, 1985). The data were collected and recorded using IRB (IRB #19-2077) with approval for video or audio recording (APPENDIX A).

Validity and Reliability of Quantitative Data Sources

In order to provide content validity evidence, the survey used in this study was sent to biology faculty which included one biology education researcher and one research focused biologist who provided feedback on survey items. This process went through two rounds of feedback. Then the pilot survey was sent to four faculty members and followed by a feedback process to understand their survey experience. The feedback improved the

survey by adding a quality check question. The feedback helped narrow down the Likert scale items by and the items were appropriately aligned with framework constructs. It also improved the general survey look, feel, and length (face validity evidence) improved.

The interview protocol went through a similar process of two rounds of feedback. Then the pilot interview was conducted with two biology education researchers and one biologist. It became clear that asking about faculty barriers to using evidence-based teaching should be added to the protocol. Some of the questions did not support answering the research questions and required editing of the language (content and face validity evidence). After this round of interview feedback, the interview protocol was updated and used in two more pilot interviews with science instructors. The survey and interview pilot feedback was invaluable, provided content and face validity, and helped inform the study instruments used to collect data.

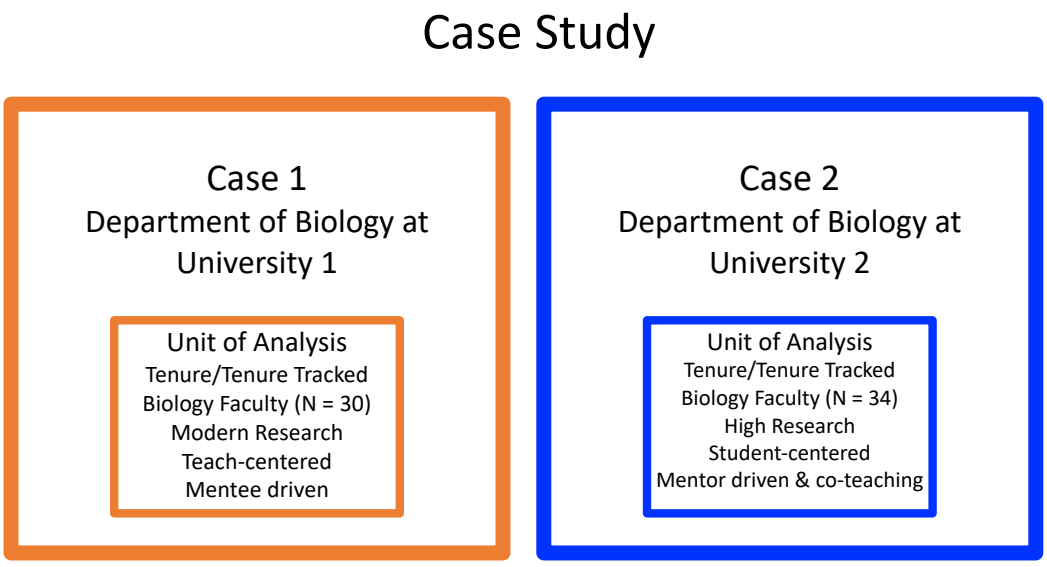
Defining Cases

Unit of Analysis - Biology Departments

Department Case 1 participants (n = 30) did not have in place the same support structures for teaching as Case 2 and is described as moderately research activity focused according to the Carnegie classification. Department Case 2 participants (n = 34) worked at a university that was highly supportive of teaching being a faculty job focus and is described as having the highest research activity according to Carnegie classification. The department cases and participants were convenience samples initially selected because of their accessibility. However, during the pilot research phase, it became clear

that the similarities and differences in each case aligned with the analytical framework and allowed this study to answer research questions on evidence-based teaching.

Both cases had department chairs and deans who were described by participants as supportive of teaching. Both cases had access to professional development through a center for teaching and learning (CTL). Both case studies were a member of a publicly funded university system. Both cases had a university enrollment of just fewer than 20,000 students and relatively the same size department.



Type 4 Case Study Design (Yin, 2014, pg. 50)

In Case 1, the introductory science class had an average of 100 students in each class, and Case 2 had almost 300 students on average in the same class type. Both departments set expectations for tenure that included publications, securing funding, and setting up a research program. Both departments had a mentorship program for new faculty. The two department cases were similar in size and make-up but had a few differences that were interesting for evidence-based teaching analysis. The importance of research and teaching were communicated differently in each department cases' tenure policy. Before analyzing

the tenure and promotion policies in these two cases, the researcher did a pilot analysis of 29 university promotion policies in 15 different states in the United States. The goal of the pilot analysis was to ensure the department case policies were typical. This pilot work also gave the researcher a sense of what kind of data could be produced from tenure and promotion policies. From this pilot work, it was clear that the department cases' policies align with policies nationwide in that the policies addressed research, teaching, and service expectations, publications, student and peer evaluations. It was also clear that Case 1 emphasized research and the Case 2 emphasized research as well but also prioritized teaching in achieving tenure.

Another reason for choosing these two cases was that one of the cases (Case 2) had a grant-funded program to provide individualized support for faculty to adopt evidence-based teaching. The case comparison was insightful and provided access to the Case 1 individuals who lacked personalized grant-funded support and access to individuals in Case 2 who had personalized support. These similarities in department and university size and differences in promotion policies and personalized support were some of the reasons for choosing these two department cases.

Embedded Units of Analysis - Participants

Participants were tenured or pre-tenure faculty nested within each department case. The researcher explained the research, data collection, risks, and intended outcomes of the research project. A consent form was provided, and participants were asked to volunteer for the study. There was no penalty for not participating in the study, and there were no rewards for agreeing to participate in the study. Participants were surveyed about the climate of their department for contextual understanding within each case. Then

participants were interviewed using a semi-structured interview modified from the Teacher Beliefs Instrument (Luft & Roehrig, 2007) (Appendix C), and a classroom recording was obtained from participants from each case. Tenure policies and other artifacts were also collected from participants' departments and universities. These data sources were all analyzed to answer research questions about faculty motivation.

Data Sources & Analysis

Survey

A survey was used to analyze each faculty's perception about the climate of their department for contextual understanding within each case. A modified survey was administered using survey items from the Survey of Climate for Instructional Improvement (SCII) and STEBI (Science Teaching Efficacy Belief Scale) instruments (Appendix B). Part of the survey was based on a modified version of the SCII from Walter et al. (2014) which measures instructional support through a Likert-scale for the constructs of collegiality, resources, respect, professional development, and autonomy. The survey responses were on a Likert scale from strongly disagree to strongly agree, with a total of six possible responses. The ordinal variables were converted into a scale 1 to 6, and an independent sample t-test was used to compare each department case by SCII climate constructs and by STEBI self-efficacy items.

The SCII has been previously validated to ensure the instrument can identify climate differences amongst groups. Walter et al. (2014, 2017) have published the instrument exploratory factor analyses two times. The means of the climate constructs were tested between institutions and had statistical significance for each construct ($p < .0001$) (Walter et al., 2014). The climate constructs loaded onto six different factors in an

expectancy factor analysis and a cluster factor analysis. Those constructs included the constructs used in this study of autonomy (three items), collegiality (six items), professional development (three items), resources (three items), and respect (five items) with each with a statistically significant mean ($p < 0.0001$). The SCII survey reported high internal reliability ($a > 0.8$) (Walter et al., 2014).

The survey sample size for both cases (n=28) was adequate for this analysis as denoted by a Kaiser–Meyer–Olkin (KMO) sampling adequacy measure = 0.604. The survey's construct reliability was found to be sufficient with Cronbach's alpha = 0.901. Climate constructs were thought of as the essentials needed by faculty for their work experience (Gappa et al., 2007). These climate constructs were designed to measure institutional climate. Climate is slightly different from the culture in that it is more direct and flexible (Schneider, Ehrhart, & Macey, 2013). Climate is the shared perceptions of company policies and regulations (Ostroff et al. 2003, Schneider & Reichers 1983, Schneider et al. 2011). Department climate and policies can influence motivation and be used to answer some of the research questions related to motivation and evidence-based teaching.

Self-efficacy items were placed in the survey from the STEBI and were used to understand the overall confidence and perceived teaching abilities of each department case. STEBI is an instrument from work by Riggs and Enochs (1990) that was rated by a panel of experts for content validity and a factor analysis with item loading was used to sort items that did not load. A final version of STEBI was given to a sample of teachers (N = 331) and STEBI reliability was estimated through an internal consistency procedure where items that did not load were rejected (Riggs & Enochs, 1990). The finalized items from STEBI were used in this study's survey. Surveys went out to all participants in Case 1 (n = 30) and Case 2 (n = 34) After the

survey was administered, participants volunteered for an interview. Basic statistically analyses and descriptive statistics were ran using some data from the surveys, interviews, and artifacts collected. Word clouds for the frequency of words were used on some of this data as well, specifically word clouds were generated from the interview data collected with faculty participants and used to give a top level view of where individuals were nested within each department case.

Interview Questionnaire

Interview data were produced through semi-structured interviews modified from the Teacher Beliefs Instrument (Luft & Roehrig, 2007) (Appendix C). The interview questionnaire was used to interview science faculty about their motivation for using evidence-based teaching and student voice. The Expectancy-Value Theory (EVT) framework was used to analyze interview data. These questions were intentional in answering the research questions and specific to analysis categories from EVT. There was one question specifically designed to understand the attainment value of EVT and how participants self-identify when it comes to research and teaching. The interviews from Case 1 and Case 2 participants were transcribed and coded in Nvivo. The interview codes were reduced into frequency distributions and used to describe the expectancies and values for each department case. Also, full interview transcription word frequency counts were used to analyze participants' statement on teaching and motivation for adopting evidence-based teaching. Both the interview codes and word frequencies were analyzed using the Expectancy-Value Theory as an analytical framework.

Analytic Framework

The Expectancy-Value Theory (EVT) is a framework that was effective in analyzing this faculty motivation data in the science undergraduate classroom context (Green, 2002). The EVT framework was used to understand expectancies and values placed on teaching, classroom voice, and evidence-based teaching. The EVT coding involved a modified version of the framework used in Finelli et al. (2014) that coded for expectancy, intrinsic value, utility value, attainment value, and cost. This analysis also used the codes from Matusovich et al. (2014). The difference in this study was the intention to look at a broad spectrum of faculty whereas Matusovich looked only at faculty who were motivated to change to evidence-based teaching. The coding system used by these two papers is described in the next section.

EVT Analysis Categories

A summary of the EVT codes used for analysis are available in APPENDIX D. Expectancy of success (E) deals with one's ability to succeed at a task (Wigfield & Eccles, 2000). Expectancy of success had five identified categories: self-efficacy, content knowledge, how-to knowledge, interpersonal relationships, and self-identify. Self-efficacy (SE+ or SE-) and self-concept of ability both deal with EVT's expectancy of success and are similar to each other. Self-efficacy was defined as an ability-related motivator (Eccles & Wigfield, 2002). Content knowledge (CK+ or CK-) is specific to the expectancy to know the content and how-to knowledge (HK+ or HK-) is specific to activities or technology such as clickers, and interpersonal relationships (IR) is relatedness to participants within the department (Matusovich et al., 2014). Access to teaching resources, professional development, and education experts was coded as OP.

The specific code OP+ was used if there were opportunities and OP- if there were a lack of opportunities.

Value (V) is essential to studying motivation because the value one places on a task are deeply embedded in one's behavior to move towards a goal (Matusovich et al., 2014). For this study, value (V) was viewed as a way to understand individual faculty motivation to adopt evidence-based teaching and increase student voice. Within the values there are four categories: attainment value (AV) (Self; SIB, SIT, SIR) (the degree to which an activity is consistent with a sense of self); interest or intrinsic value (IV) (activity enjoyment) (IN+ or IN-); utility value (Use+ Use-) (UV) (activity usefulness); and cost value (CV) (the activity cost expense of engaging or not) (Eccles, 2005; Wigfield & Eccles, 2000). This study made an assumption that self-identity (SI) falls under the attainment value and SI was coded as self-identifies as teacher (SIT) self-identifies as both (SIB), and self-identifies as researcher (SIR). The values of cost included resources, money, and for this study content, control, and voice (Eccles, 2005). The cost of voice is the value on who is talking in the classroom, instructor voice value (IVV), and student voice value (SVV). Matusovich et al. (2014) found two subcategories for the value of cost; one being the cost of getting tenure (AT) and the other being the time it takes to engage students (EV). For coding, the cost of achieving tenure was coded as AT and of engagement or the value of engagement/interaction as EV. Autonomy was coded as AU. The EVT framework and codes were used in thinking about what department documents and policies were also communicating about teaching expectations.

Departmental Artifacts

Artifacts are any data sources collected that can tell us what is happening in the classroom and within the department as far as expectations for teaching (Mills & Gay, 2016). Department documents, policies, and faculty awards were analyzed and used to compare the two department cases. Department documents and policies were examined to look for instances of expectancies and values as related to teaching expectations, instructor voice, student voice, and evidence-based teaching.

Nvivo was used to analyze department cases tenure and promotion policies for what was communicated about teaching and research expectations. The promotion policies were analyzed using a word frequency for critical works related to teaching, research, students, and learning. The policies were also analyzed for any promotion evidence expectations such as student evaluations, grants, or teaching awards. The goal was to understand what each department case considered as evidence of quality teaching and how were they communicating that to faculty. Teaching awards data was collected from public records. The awards data was calculated to see how many awardees existed in each department compared to each case university. Another quantitative measurement used to compare the cases involved in classroom voice data, using the Decibel Analysis for Research in Teaching tool.

Decibel Analysis for Research in Teaching (DART)

The video/audio classroom data were analyzed using Decibel Analysis for Research in Teaching (DART), a method that analyzes classroom sound and provides an output for percent of voice (Owens et al., 2017). An audio/video recording was collected from one class that the participant said represented their typical classroom. The files were

converted to an audio file format appropriate for the DART upload software and uploaded through the web-based DART system. An additional verification process occurred with each DART output. The researcher listened along with the DART output and completed a human annotation to ensure that the output aligned with the actual classroom experience and percentage of voice. The post DART run needs a human annotation to capture what is explicitly happening at each change in volume (Figure 7). DART does not indicate if the classroom is experiencing active learning strategies such as think-pair-share (Figure 7). DART can indicate the likelihood of who is talking and by how much of the classroom time and this was used for triangulation of the data. For example, if a participant said in the survey that they talked 98% of the time, the DART output could be viewed and confirm if this self-reported data was close to accurate. DART participant data was reported for each department in chapter IV.

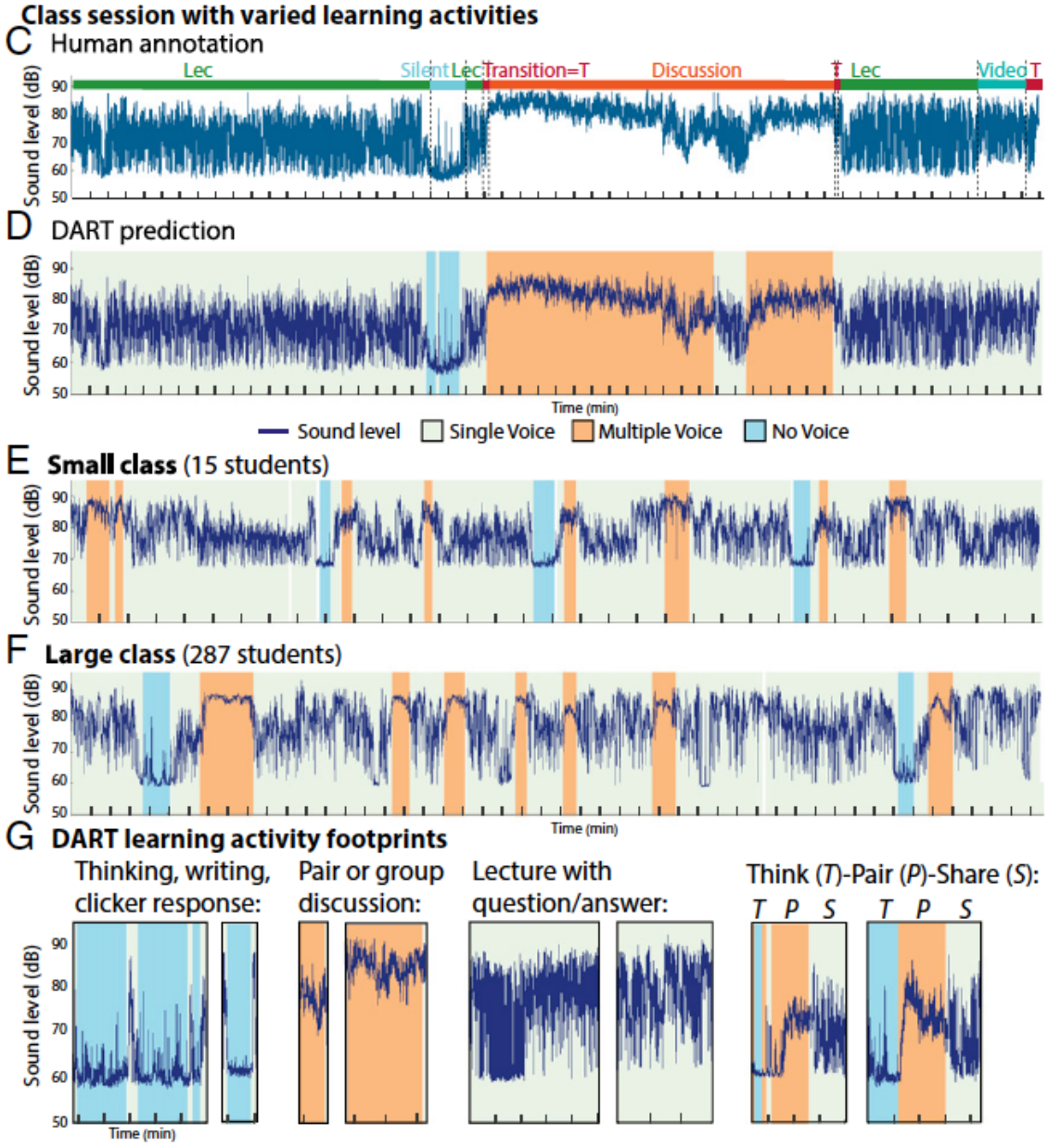


Figure 7. DART. Decibel Analysis for Research in Teaching (DART) Owens et al., 2017, pg. 3087

Researcher as Instrument - A Self-Analysis

Before describing the research results involving other teachers, it is important that the researcher do a self-analysis using some of the same analytical tools. It was essential to do a self-analysis and provide the researcher's perspective on teaching and learning to

reduce bias in this work. This work began because of my interest in classroom student voice. I began graduate school as an advocate for student voice often asking why were students not talking more in class. Five years later, I became a faculty advocate especially after I measured student talk in my class. I thought students were talking a lot in my classroom. I was wrong. Before I could ever discuss research results, it was essential to analyze my teaching.

In March 2017, I used an evidence-based teaching strategy of exploring an NSF case study with about 75 students in an introductory biology course. The lesson plan took weeks to prepare. There were clicker questions and a few student pair and share moments. I left the class thinking student were engaged, and I believed I had them talking more than most of their other classes. I uploaded the audio file into the DART software, and the sound data told a different story. The classroom talk data were very clear that I was learning a lot about the cell cycle and cancer. The DART output revealed that I talked 99% of that class (Figure 8). I have since then frequently measured the classroom talk in my classroom. In 2019, I measured the classroom talk in my classroom with 260 students, the largest class size in my teaching history. In this class, I was talking 72.5% of the time and students were talking 27.5% of the time (Figure 8).

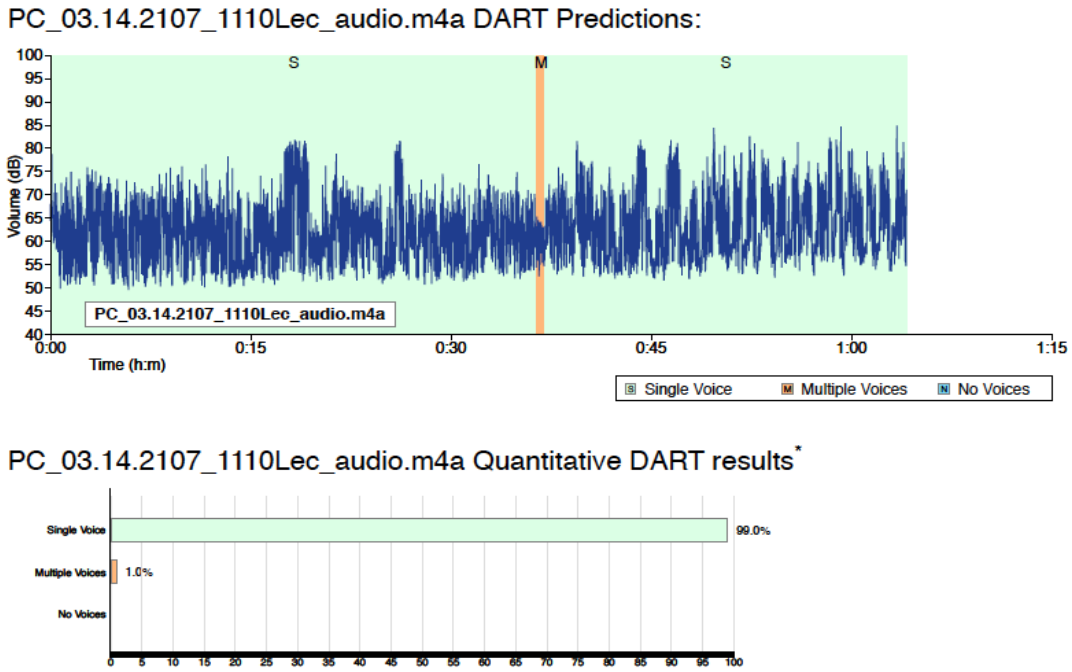


Figure 8. Researcher's DART output from 2017 showing results of 99% instructor (single voice) talk, 1% student voice (multiple voices) and 0% no voice in this particular class.

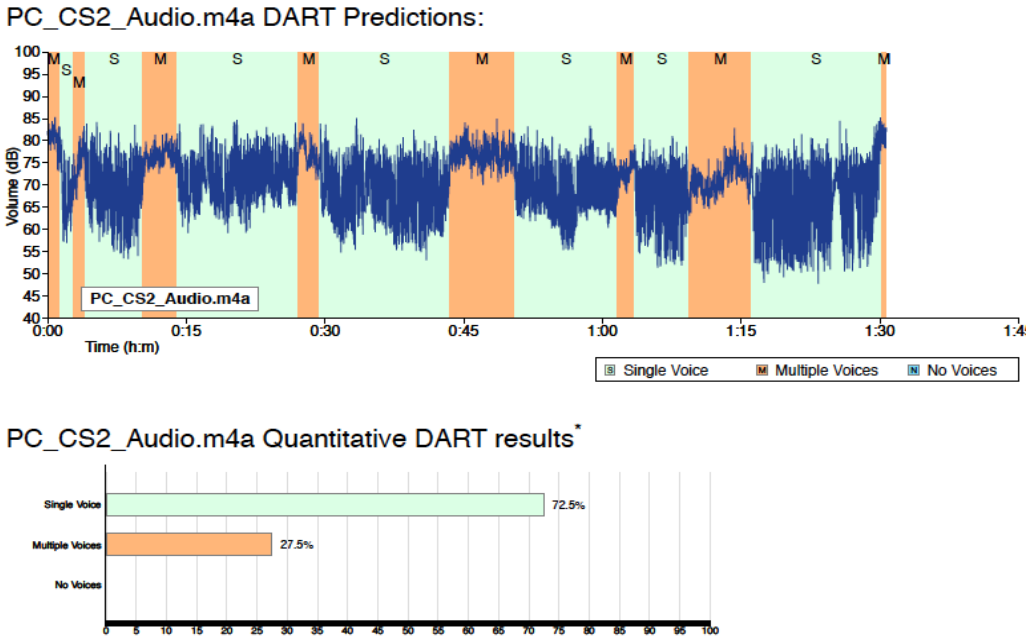


Figure 9. Researcher's DART output from 2019 showing results of 72.5% instructor (single voice) talk, 27.5% student voice (multiple voices) and 0% no voice in this particular class.

The 2019 DART output (Figure 9) is showing an attempt to work with the student attention span of 15 minutes (Wankat, 2002). You can see (M) for multiple voices about every 15-20 minutes (Figure 9). I learned through my own reflective practice that the classroom talk data is one indicator of what is going on in the classroom but not the sole indicator. I can also now view this DART data output and see how the lesson plan is working with the attention span countdown clock that begins as soon as I start to lecture. I am working with the knowledge that after ten minutes of a lecture the students may remember 70 percent of what I just said (Hartley & Davies, 1978). I can analyze my classroom data and see how long I talk and know the likelihood of content retention. I can look at this specific analysis of my DART output from 2019 and know that there is

not a lot of thinking or silence in this particular class indicated by the 0% for no voice. In my reflective practice, I know I need to work on giving students more time to think and focus on more wait time after questions. The point is that I made my assumptions about classroom talk and student learning. Measuring these assumptions with an evidence-based teaching tool has helped improve student engagement and hopefully learning in my classroom. The use of DART is explained in chapter IV and further explored as a tool for PD in Chapter V.

CHAPTER IV: RESULTS

Introduction

The expectancy-value theory (EVT) was used as a framework for understanding the motivations and moderators of a movement towards evidence-based teaching in higher education. Using EVT as an analytical framework has allowed the researcher to capture the perceived abilities for success (expectancies) and the perceived values placed on adopting evidence-based teaching practices in two case departments. The following sections address each research question in turn:

1. *Are students talking in these department case classrooms and how do the case's classrooms compare in terms of student classroom talk?*
2. *What motivational components influence science faculty in two department cases to adopt evidence-based teaching and use student voice in the classroom?*
3. *What situational conditions support science faculty motivations for focusing on teaching practices based on evidence?*
4. *What do science faculty members perceive would have to change in their department or within themselves to adopt evidence-based teaching that prioritizes students' voices?*

Part 1 – Student Talk

Are students talking in these department case classrooms and how do the case's classrooms compare in terms of student classroom talk?

It was essential to have a baseline of the classroom voice data for each department case. The original hypothesis was that the classrooms with high student voice would be using more evidence-based teaching (Owens et al., 2017). Classroom voice data is an

important measure for understanding the differences and similarities in the use of evidence-based practices between the two cases. Student voice was described as a product of evidence-based teaching from the researcher's theoretical perspective in the PPSP model in Chapter II.

Self-Reported Classroom Talk Data

The survey asked participants to report the percent of instructor and student voice in their typical classroom. An independent t-test was run on the self-reported class talk percentages for department Case 1 (n = 17, M = 88.53, SD = 11.67) and department Case 2 (n = 12, M = 82.33, SD = 18.53). The differences between the self-reported percentage of single voice instructor talk were statistically significant $t(27) = 1.12$, p =0.047). Case 1 participants mostly reported a student voice percentage that was far less than the teacher voice percentage in their classrooms. Ten participants in Case 1 said they were talking 98% of the time in class and seven instructors said they were talking 75% of the time. In department Case 2, six participants stated they were talking 98% of the class time, four participants said 75% of their class was instructor talk, and two participants said the talk was equal between the instructor and students (Figure 10).

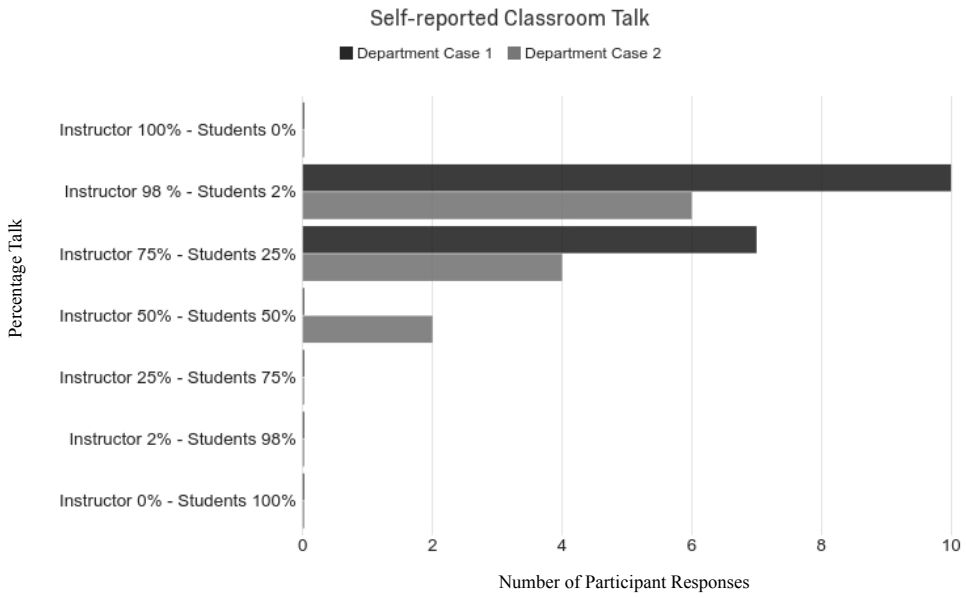


Figure 10. Self-reported Survey Data on Classroom Voice generated from participants in each case.

Classroom Voice DART Data

The classroom audio recordings were analyzed using the Decibel Analysis for Research in Teaching (DART) (Owens et al., 2017). The DART output files were human annotated to verify if the percentage of voice for a single voice (SV) (aligned with instructor's voice), multiple voices (MV) for student voice, and no voice (NV). An example of a DART output from each department case is in Figure 11.

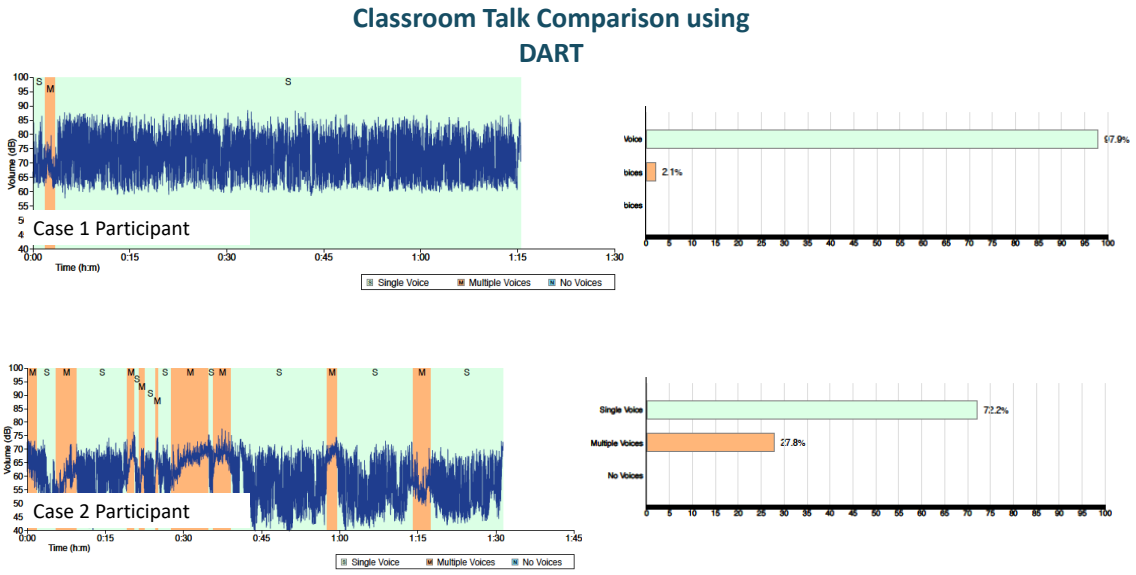


Figure 11. DART output examples from each case with the volume output on the left and the corresponding percent of voice output on the right.

The classroom voice data was collected from a sub-sample of participants who provided consent (Case 1 n = 5; Case 2 n = 4) and analyzed for single voice (SV), multiple voices (MV), and no voices (NV) (Figure 12 and Figure 13). The names used in Figure 12 are pseudonyms.

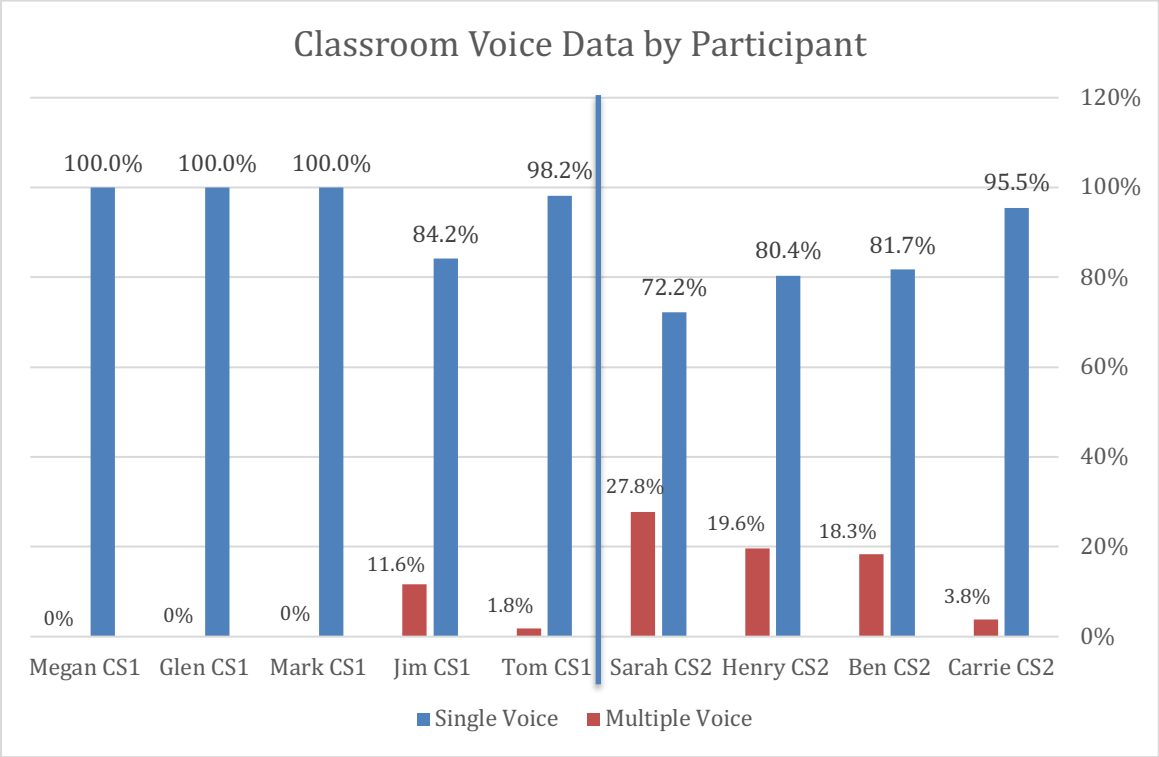


Figure 12. Classroom voice data by the participant in each case from the DART analysis of audio recordings. CS1 is Case Study 1 and CS2 is Case Study 2.

The classroom voice DART data from audio recordings showed a statistically significant difference for single voice ($t(7) = 2.55$, $p = .038$) between department Case 1 ($n = 5$, $M = 96.48$, $SD = 6.91$) and department Case 2 ($n = 4$, $M = 82.45$, $SD = 9.66$). The classroom voice DART data from the classroom audio recordings showed a statistically significant difference for multiple voice ($t(7) = -2.89$, $p = .023$) between department Case 1 ($n = 5$, $M = 2.68$, $SD = 5.05$) and department Case 2 ($n = 4$, $M = 17.37$, $SD = 9.97$). There was no statistically significant difference for no voice ($t(7) = 0.69$ $p = .513$) between department Case 1 ($n = 5$, $M = 0.84$, $SD = 1.87$) and department Case 2 ($n = 4$, $M = 0.18$, $SD = 0.35$).

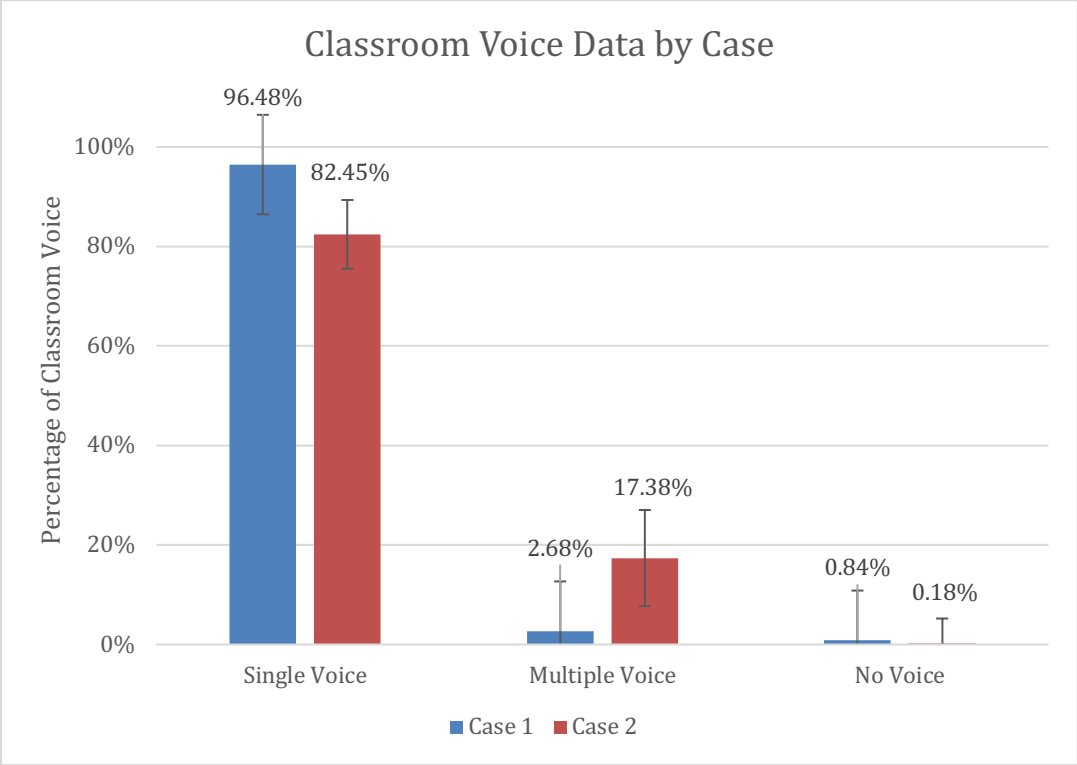


Figure 13. Average percent of classroom voice data from the DART data of single voice, multiple voices, and no voice between the case department.

The classroom voice DART data showed variation in the instructor talk and student talk. These data align with the self-reported survey talk data. Case 1 participants self-reported that overall one would see more instructor talk in their classrooms and Case 2 participants reported a lot of instructor talk as well. However, there was more self-reported student voice in Case 2 in both the self-reported survey data and the DART analysis. The difference in student voice is relevant to the discussion on the adoption of evidence-based teaching and will be discussed further in Chapter V.

Part 2 – Motivational Components

What motivational components influence science faculty in two department cases to adopt evidence-based teaching and use student voice in the classroom?

Evidence for What Influences Science Faculty Motivational Components

The primary data source used to answer this question was through the semi-structured interviews. Clear influences on motivational components from the perceived expectancies of success in evidence-based instruction and perceived value of evidence-based instruction of participants emerged in this analysis using the expectancy-value theory. Specific expectancies such as class size and tenure emerged as influences on the motivation to adopt evidence-based teaching in both cases. In order to get a rough-grained estimate of comparisons in faculty motivations between departments, a word-cloud was generated from interview data as described in the protocol in the previous chapter.

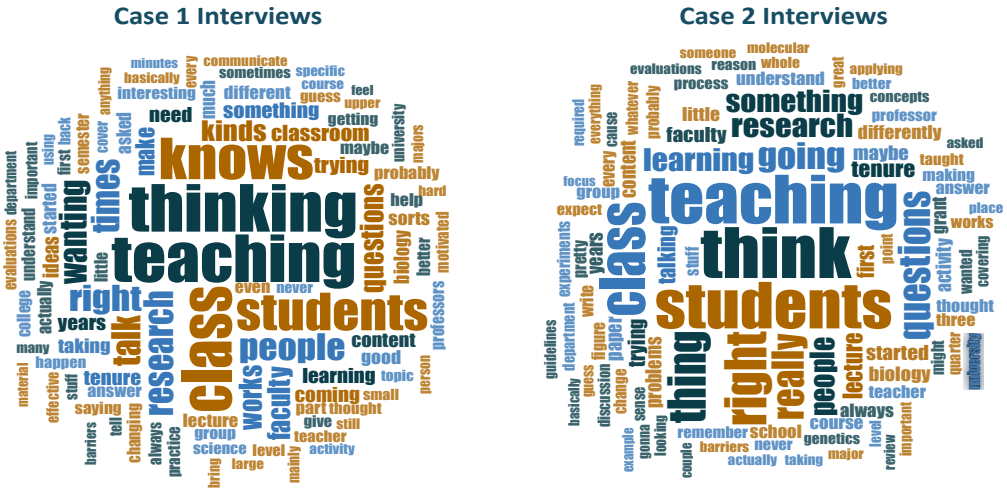


Figure 14. Word cloud generated from interview data from participants in each department case.

A keyword in the Case 1 word cloud was "knows." Participants when talking about coverage of content often referenced that students knowing the content was important. Participants were asked if retaining content knowledge or being able to say they had heard of a topic was more important. Case 1 participants felt strongly that honoring their place in the curriculum by covering a broad amount of content topics was important. Some participants explained that they had low expectations for content retention by students but were motivated to ensure that students could not say topics were not covered (Table 9, n =2).

The word frequency of Case 2 was focused on teaching, thinking, students and learning (Figure 14). Case 2 participants wanted students to be doing research and experiments in class. They wanted students to have the experience of being critical of experiments and reasoning their way through the process of how science works. They wanted students to think like scientists; hence "think" was the main theme in Case 2. Case 2 faculty wanted activities where students were interpreting and analyzing real data. "Thinking" and students were big themes for both cases, but the expectancies and values for how to address student thinking were slightly different.

Those differences emerged through the interview transcription coding process using the specific expectancy and value themes pre-determined from the expectancy-value theory. Those differences were divided by case in the first half of this next section followed by a more in-depth analysis into the specific expectancies and values that were significant themes in each case. These findings are then summarized at the end of this chapter.

Department Case 1's Expectancies and Values Summary

This section begins with a summary of the interview codes for expectancies, the ability to succeed at using evidence-based teaching. The EVT expectancy and value codes were converted to frequency distributions for both cases (Figure 15; Figure 16). A chi-square test of independence was performed on the observed frequency of value codes X^2 (1, N = 17), p < .000) and on the observed frequencies of expectancy codes X^2 (1, N = 17), p < .000) of Case 1 and Case 2. Results demonstrate a statistically significant variation in the frequency distributions of utterances related to the expectancy of success and value of evidence-based teaching between the two cases.

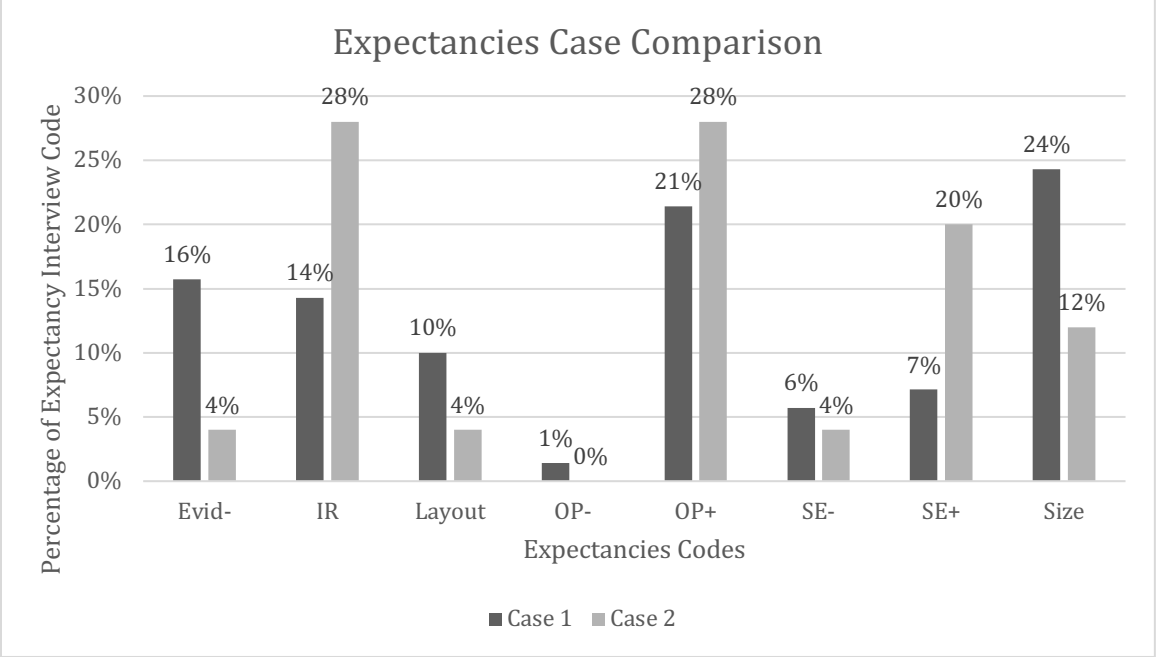


FIGURE 15. Interview data from each case department by percentage of the expectancies for success to adopt evidence-based teaching. Evid- stands for the need for credible evidence that aligns with an increase in student performance. IR is for interpersonal relatedness. Layout is for class layout and size is for classroom size. OP is for opportunities, and SE is for self-efficacy.

In department Case 1, the percentage participants mentioned the following expectancies to succeed in evidence-based instruction, class size was 24%, opportunities was 21%, the perceived lack of evidence for EBT and student results (Evid-) was 16%, interpersonal relatedness (IR) was 14%, class layout (Layout) was 10%, and positive and negative self-efficacy was 7% (SE+) and 6% (SE-). (Figure 15). In Case 1, some participants mentioned some issues with using evidence-based teaching in larger classes, but overall this group felt confident in their abilities for classroom facilitation of evidence-based activities such as group discussion.

The values placed on achieving tenure (AT) (14%), engagement with peers and students (EV) (12%), investment of teaching time (Time) (11%), the value placed on content coverage (Content) (10%), positive interest (IN+) in evidence-based teaching (9%), usefulness or utility of a evidence-based teaching (Use+) (8%), control of the classroom (6%), autonomy as it relates to their role as a faculty member (AU) (4%), and instructor voice value (IVV) (5%) were major themes in Case 1's responses (Figure 16). These were the values on the task of using evidence-based teaching that Case 1 participants mentioned most often and what likely could influence their motivation to adopt evidence-based teaching.

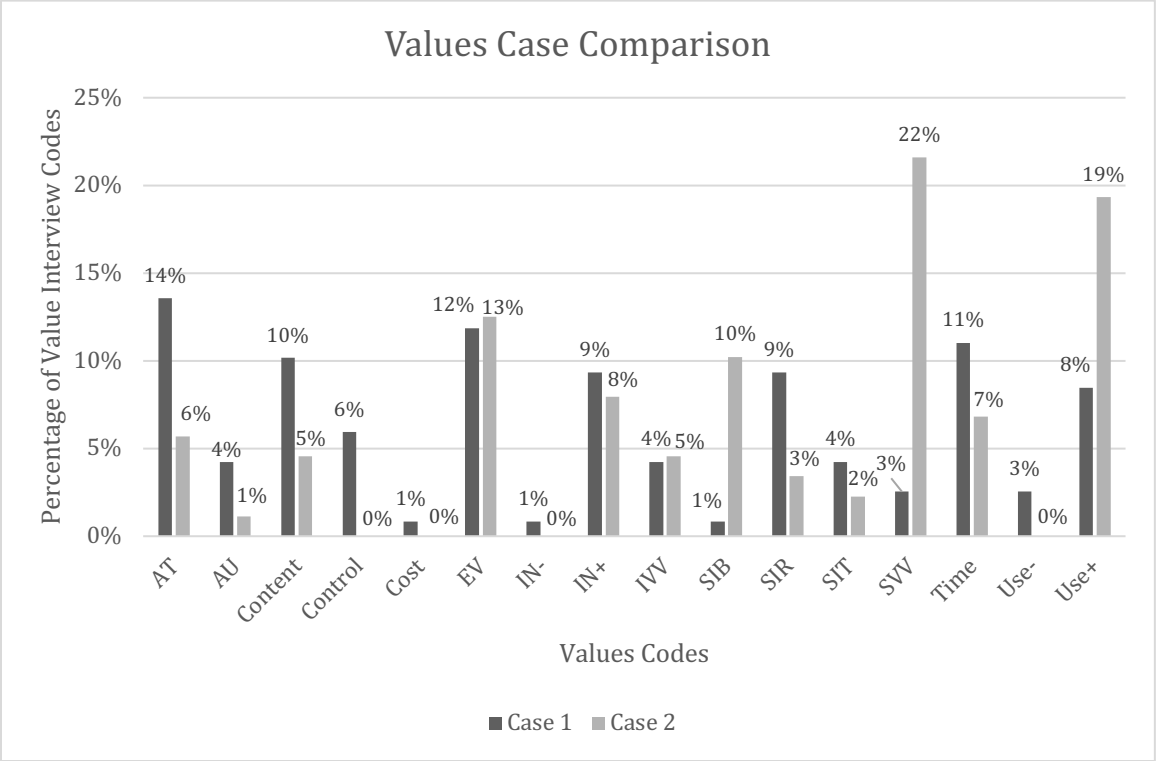


Figure 16. Interview data from each case department by percentage of the values for the task of adopting evidence-based teaching. AT is achieving tenure, AU is autonomy, EV is engagement value, IN is interest value, IVV is instructor voice valued, SIB is self-identified as both, SIR is self-identified as researcher, SIT is self-identified as teacher, SVV is student voice valued, and Use is the utility value or usefulness of evidence-based teaching.

In Case 1, participants self-identified as a researcher (SIR) was coded with a frequency of 9%, self-identifying as a teacher (SIT) was coded 4% of the interview text, and self-identifying as both (SIB) was coded in 1% of the textual utterances. These participants indicated that they valued engagement (EV) and interaction with students and peers. The participants valued their own time, classroom control, and autonomy in

their faculty roles. The value of content coverage played a major role in the tasks involved in teaching for department Case 1. The next section is about department Case 2's results for statements they made related to expectancies and values for motivation to utilize evidence-based practices.

Department Case 2's Expectancies and Values Summary

In department Case 2, participants mentioned more often the following expectancies to succeed as class size (12%), opportunities (OP+) (28%), the need to see the evidence for EBT and student results (Evid-) (4%), interpersonal relatedness (IR) (28%), class layout (4%), and self-efficacy as SE+ (20%) and SE- (4%) (Figure 15). These participants felt confident (SE+) in their ability to facilitate evidence-based teaching strategies.

Most participants felt that class size and class layout were barriers to teaching. Case 2 participants placed much value on student voice (SVV) in the classroom (22%) (Figure 16). These participants felt that the tasks involved in teaching and EBT adoption were of use (Use+) (19%). Similar to the participants in Case 1, this group valued student engagement (EV) (13%) and were interested (IN+) (8%) or enjoyed teaching as well as evidence-based teaching strategies. Department Case 2 also felt time investment for teaching (7%) and achieving tenure (6%) were important considerations when considering the value of utilizing evidence-based practices. This department placed less value on content coverage (5%), instructor voice (5%), and autonomy (1%) and there was minimal mention of valuing control of their classrooms and or considering the cost to implementing evidence-based practices.

Comparing Expectancy and Values Frequencies of Cases

These expectancies and values in each case department were the motivational components found to influence science faculty in the adoption of evidence-based teaching in these two contexts using an EVT framework. At an individual level, these are essential motivators to consider when working with faculty and designing professional development opportunities. This is why a more in-depth analysis using specific excerpts gleaned from each case are described in the next section.

Detailed Expectancy Themes

Expectancy to succeed is deeply rooted in the ability to move forward and engage with a task (Eccles et al., 1983; Wigfield & Eccles, 2000). This next section lays out the specific expectancies mentioned in this study. Faculty communicated they had the abilities to facilitate evidence-based teaching and it appeared that they believed they could be successful in this task. This was evident in the self-efficacy data from the survey (shown later in this chapter) that showed participants in both cases indicated high confidence in any facilitation skills required to use evidence-based teaching. However, the interview data produced mediators and barriers inhibiting their expectancy to succeed in using evidence-based practices. Case 1 participants were clear that class size was an obstacle for adopting evidence-based teaching. Class size and other major expectancy themes are addressed in the next section.

Class Size and Layout as Mediators of Expectations of Success

For purposes of this discussion, the researcher has placed the expectancies for class size and class layout together. The class size code referred to references in the interviews related to the total student enrollment number and class layout referred to the

physical seating and arrangement of the classroom. Often in large lectures classrooms, one may see a physical layout that has a stadium-like seating to accommodate larger classes. Before discussing class size, the culture and specific class sizes typical to each department must be explained.

In Case 1, there were science classrooms specific to lecture that were intended to hold 75 students and up to 300 students. In Case 2, some classrooms would accommodate up to 500 students. An introductory biology class in Case 1 has an enrollment typically of 100 students, and in Case 2, an equivalent course was capped at just under 400 students. Case 2 also offered a version of this same course, in what they referred to as an "active learning course." They capped this course at 90 students, and it was held in a room recently devoted to active learning by reorganization of its physical structure. There were round tables and seats for students around the tables. These active learning classrooms were grant-funded and designed to be flexible to support a variety of configurations and approaches to teaching and learning. Some of the specific statements related to these findings for class size and layout are in Table 1.

Table 1

The Expectancy of Success Mediated by Class Size and Layout

Case	U	Participant Excerpts
1	1	My class of about 75 students, I cannot find a good way to flip it and effectively use the time that I have available to contact the hours.
1	2	The first half of the semester the professor gave lectures on a particular topic, but the second half was all student-led...that works for small classes...that will not work for a class with 75.
1	3	The barrier is just the sheer number.
1	4	Well, that works great in a small classroom it works great. It's just too hard to get those students in the back.
2	5	I have no idea whether "best practices" which now seems to involve "active learning" scales to classes >300.
2	6	If it were smaller, I think it would be far more interactive. I would have students contributing constantly.
2	7	I think the size of it, you know, the room is just pretty daunting. As far as rooms go, that's the place. You have the central aisle and the two outer aisles. You can kind of get in.

Note. The U value references an interview utterance from specific excerpts for class size/layout.

Case 1 participants created a clear distinction between the teaching strategies they used for small and large classes (Table 1, U = 1, U = 2, U = 3). In a large class, most participants stated they used traditional lecture, sometimes with Q&A, and some clicker questions. If they were teaching a smaller class, then they often self-reported the use more engaging (evidence-based) strategies such as peer lead discussion, group work, and presentations.

Many Case 2 participants described using active learning strategies in small classrooms as an expectation from some peers and the department. These participants also described a climate where their peers modified the use of EBT for the larger classes. As explained, this department had participants who had not fully adopted these strategies, but they were aware of them. The best example of this is this participant excerpt in Table 1 (U = 5). In this interview, this participant was clear that the department was changing and faculty were expected to change with it. She thought there was an expectation of using active learning with a 300 plus student course. This expectation of trying evidence-based teaching was a theme through many of the Case 2 interviews.

Case 1 participants had some expectations on what an active learning classroom should look like, but it was not a communication theme as seen in Case 2. Some participants in Case 1 believed that that education researchers expected everyone to "flip" a classroom to solve the research-to-practice gap (Table 1, U = 1). Both cases were aware that science education research existed, but the interview data revealed alternative conceptions related to the "trendy" strategies they had heard. Participants in both cases did not understand how a large lecture class could be "flipped."

Another issue may exist in the definition of what a large class is. The perception of a small and large class scale was different in the cases. Case 1 participants felt a class less than 75 people were smaller and a class "closer to 24" students was ideal (according to two participants). In Case 2, this university was dealing with a similar enrollment number of just under 20,000 students. The Case 2 classes were organized so department Case 2 faculty were often teaching introductory classes with 300 students although the active learning version of this course was capped at 90 students. However, in Case 2,

some of the participants were using evidence-based teaching in their small and large classes. Case 2 participants often exchanged ideas with peers about how to work with the layout of the class. Some of the participants had learned from a department mentor to rope off a few rows so faculty could get to the interior rows of a stadium classroom's seating.

Strength of Educational Research Evidence as a Mediator of Expectancy of Success

During the pilot process of this study, the need for personalized faculty support and the need for EBT evidence emerged were communicated by pilot participants. Therefore, an individual's consideration of education research evidence was considered as a critical predictor of expectancy of success in the EVT framework. During this analysis, Case 1 participants say they had credibility issues with the evidence for science education research (Table 2). There was minimal talk of needing credible evidence to adopt or try evidence-based teaching with Case 2. All of the excerpts for the expectancy of evidence come from Case 1, and that is no surprise as the evidence frequency code was uttered 12% in the Case 1 interview data (Table 2; Figure 15).

Table 2

The Expectancy of Evidence

Case	U	Participant Excerpts
1	1	Many of us have tried different methods but do not really seem to change student results.
1	2	Approach or practice, whatever, all those terms that have swept through in the last 10-20 years. I'm aware of all of them but have not seen a change in student performance.
1	3	I have seen some of the evidence but it does not convince me fully that the different practices are better than others.
1	4	I think that you presented with bio ed research on the exact same way they are presented with their day to day research. I think if bio ed researchers were better at describing their work in relation to how the people they're trying to reach see their work. the message would be much better received.
1	5	You must not try to convince them that you're right, you need to show them.

Note. The U value references an interview utterance from specific excerpts for the need for credible evidence of science education research.

Some participants suggested that science education research needs to be presented in a similar way to how faculty see evidence presented in their discipline (Table 2, U = 4, U = 5). Within each sub-discipline, the evidentiary standards and practice for reporting results may differ. It is important to consider what the standard looks like within a discipline to understand the lens faculty are using to view education evidence. The participants in Case 1 indicated they had tried different teaching strategies, but the effort did not appear to improve student performance on exams or in a course (Table 2, U = 1, U = 2).

The Case 1 participants experience with trying different strategies aligns with the Case 1 survey data that asked about the effects of teaching effort on student performance. Department Case 1's survey data results (n = 17, M = 2.47, SD = 1.281) appeared to

disagree that student achievement is due to ineffective teaching compared to department Case 2 (n = 11, M = 3.64, SD = 0.809). There was participant response variation between the two cases departments with Question 3 (Q3) of the survey, *if students are underachieving in science, it is most likely due to ineffective science teaching*, $t(25) = -2.95$, $p = .007$ (Figure 17; Figure 18). Department Case 1 (n = 17, M = 3.29, SD = 1.31) and department Case 2 (n = 11, M = 2.64, SD = 1.027) disagreed on a related Likert-scale survey question, Question 4 (Q4) (Figure 17; Figure 18). There was no statistically significant variation between the two case departments with survey Question 4 (Q4), *increased teaching effort produces little change in student's achievement*. $t(25) = 1.40$, $p = 0.151$) (Figure 17; Figure 18).

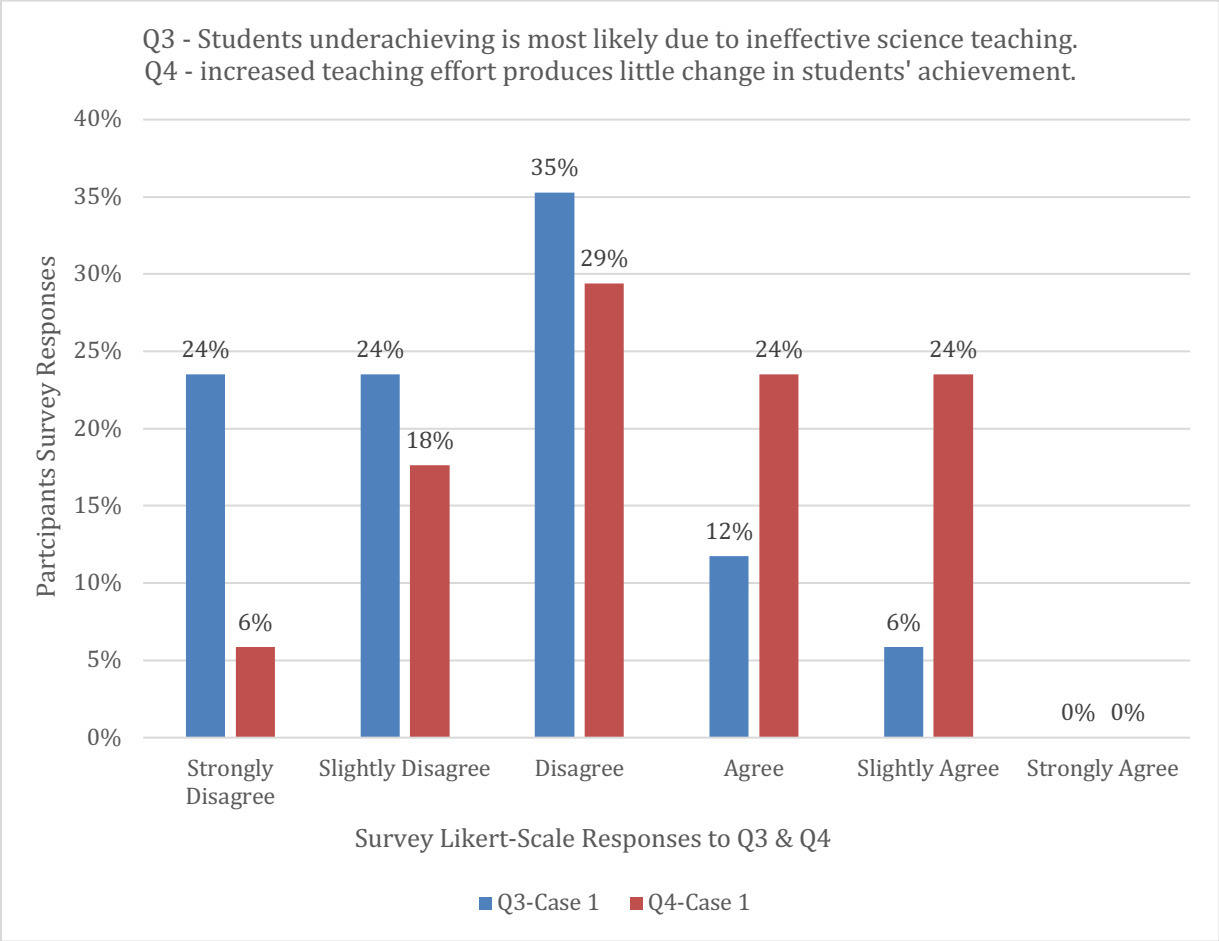


Figure 17. A comparison of teaching effort and student achievement for Case 1 from survey question 3 (Q3) and question 4 (Q4).

However, Case 1 indicates that student achievement and teaching are not interconnected as can be seen from their combined question 3 and 4 responses (Figure 17). Some Case 1 participants said that they felt that changes in their teaching performance did not lead to higher student performance. This may indicate that there are issues with the ability to succeed, meaning there is not an opportunity for Case 1 participants to even consider the value of evidence-based teaching. This lack of

opportunity may be important, especially, if some faculty think that evidence-based teaching does not produce results and that the task is not supported by credible evidence.

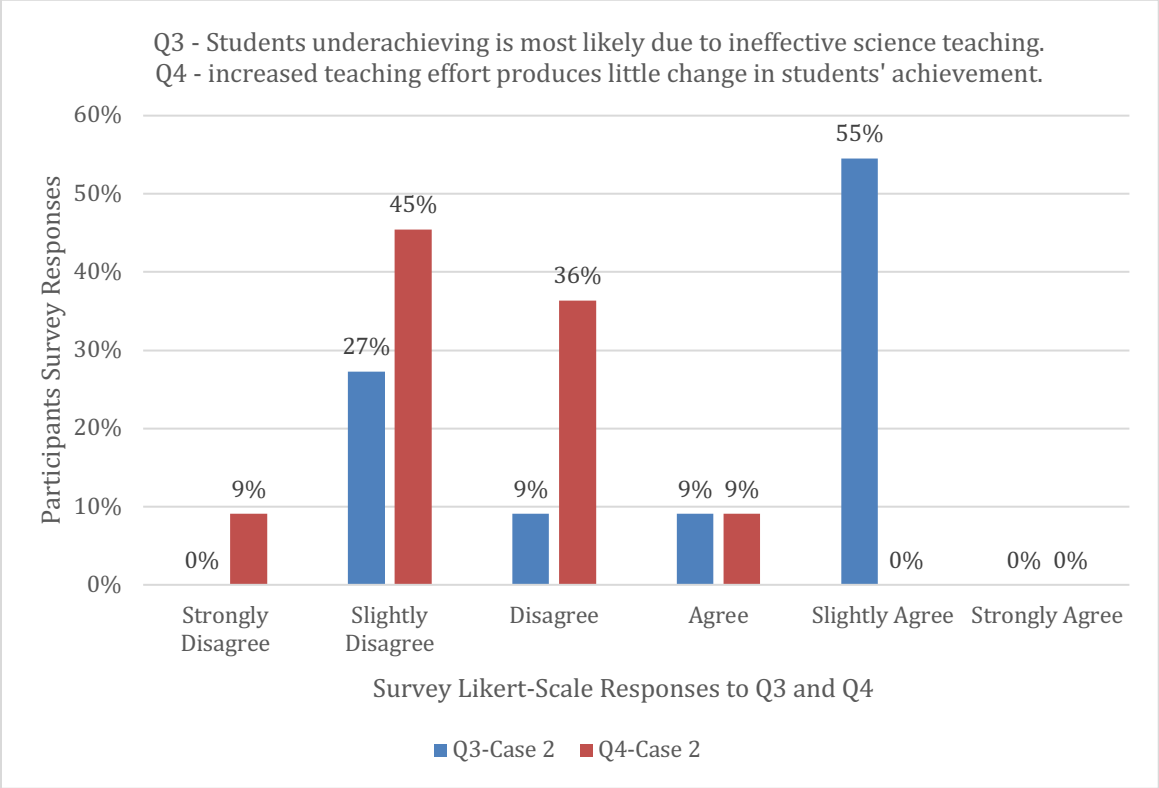


Figure 18. A comparison of teaching effort and student achievement for Case 2 from survey question 3 (Q3) and question 4 (Q4).

In Case 2, these participants seemed to agree that increasing teaching effort can influence student achievement (55%) (Figure 18). Not all of Case 2 participants agreed that increased teaching effort supported student achievement. However, they generally disagreed with the statement that students underachieving is not related to teaching. Case 2 participants felt that teaching effort could have an impact on student achievement. There was a sense that engaging students through teaching could have an impact on student achievement.

Engagement with students and with peers was valued in both cases. Opportunities to engage with peers and experts through a lens of interpersonal relatedness is explored in the next expectancy for success section.

Educational Opportunities and Interpersonal Relatedness as Mediators of Expectation of Success

Interpersonal relatedness (IR) was a factor for engagement with evidence-based teaching in a similar study (Matusovich et al., 2014) that combined both access to PD, education experts, and collaboration with peers. This study separated the interpersonal relatedness (IR) code from Matusovich et al. (2014) into IR and opportunities (OP+ or OP-). Opportunities were defined as having access to teaching resources, experts, and PD. IR was defined as opportunities to work with others, specifically department peers (non-experts). This study used the codes for opportunities and interpersonal relatedness to distinguish between working with experts. The opportunity to work with department peers who are not educational experts was coded as IR. The opportunity to work with educational experts was coded as OP+ or OP-. In both cases, the participants had access to education experts inside and outside their department. Both cases have access to professional development through their centers for teaching and learning (CTL). Case 1 had a frequency distribution for OP+ as 16% and IR as 11%, and Case 2 had a frequency of 18% for OP and 18% for IR (Figure 15). Participants in both groups were open to professional development, and one participant from Case 1 said their attendance would only require an invitation (Table 3, U = 3).

Table 3

The Expectancy of Opportunities

Case	U	Participant Excerpts
1	1	I had (an expert) observe my class and he was able to use all the right kind of pedagogical terminology to showcase my style. I think that that worked well, but I also had a few other professors that were not so familiar with the bio-ed aspect of it, so to evaluate it, and those went well as well.
1	2	I do some, and I actually try and failed, you know (the expert) of course, I wanted to sit in his class to see how he does what he does.
1	3	I'd be open to that. I do not really think I'd need an incentive, maybe just an invitation.
1	4	Faculty members stated that they would workshops focused on teaching improvements. You know like they do not want to go, some of the (Center for Teaching and Learning) things are kind of tough because it's people talking about what they did in their class and that's not always transferrable. Especially if it's like a history professor or something. I think if we could have somebody who's specifically for biology to come in and say you know, this is the evidence that, you know, this is uh an effective way to get students to learn and then kind of, present it in a very biology focused way, I feel like faculty would be very interested in that, engaged in that.
1	5	Faculty are open to things that would help improve their teaching. It needs to be kind of specific to what they're trying to teach and their own personal style is.
1	6	I personally think that the impact of bio ed education, in particular, is probably some of the most impactful stuff going on in the biology department.
2	7	I talk to (an expert) about active learning techniques. I generally bounce material, content, how to deal with students.
2	8	There were about 12 of this, and they did this every year, and it was, I think, in the summer.

Note. The U value references an interview utterance from specific excerpts for the expectancy for opportunities for access to resources, experts, and PD.

Case 1 participants were clear that they are open to opportunities and could collaborate with peers on teaching. They requested that the opportunities be brought to their department and be discipline specific. One of the participants talked about attending

workshops at Case 1's CTL, and that hearing what history professors were doing did not apply to their teaching practice (Table 4, U = 4). A few participants in Case 1 described that they have a science education expert in their department. This expert helped because they used "all the right kind of pedagogical terminology to showcase my style" and this helped translate his style in biology education terms to his faculty peers (Table 3, U = 1). One Case 1 participate expressed an interest in observing the class of an expert in his department but failed to make it there (Table 3, U = 2). The interest in opportunities to utilize teaching resources exists in both cases. The task of collaborating and talking about teaching was explored using the expectancy of interpersonal relatedness (IR). Case 1 had a frequency distribution for code IR of 11%, and Case 2 had an IR code frequency of 18%; one of the highest expectancy themes for Case 2 (Figure 15). The IR excerpts were collected after asking participants directly in the interview if they talk to their peers (Table 4). In Case 1, some of the participants talked to their peers about teaching. Case 1 participants indicated they talked to their peers very little, sometimes, and often it was isolated to one person (Table 4, U = 2). However, there was a small group within that department that had, over the years, formed a professional learning community (PLC) organically (Table 4, U = 4).

Table 4

The Expectancy of Interpersonal Relatedness

Case	U	Participant Excerpts
1	1	I had a conversation with (a peer) about the advantages and disadvantages of clickers.
1	2	Not much. Um, the only person I've talked to about teaching practice is (a peer).
1	3	I would say the biggest barriers were that my colleagues did not talk about teaching.
1	4	The only reason I started doing that was because about seven years ago, we started a faculty learning group. And we sat together weekly throughout the whole semester, and we decided to create a common exam. And all of us sat in a room every week, and we kind of debrief about what's going on. And, it was probably one of the most informative and best experiences about teaching I've ever had.
2	5	I wrote down a list of things because I received this advice that you're going to do it, and it's going to be a blur. Think about what you would do better next time. And write that down, and then come back to it.
2	6	R - Like you have a colleague who will do exam analysis. You have another colleague who will help you with material and content, and another colleague you talk to about pedagogy. You get that that's rare, right? P - Yeah. R - Yeah, that's like really rare. P - Well that's one of the things like why you know the level of teaching I look for. It's also more this was always the dream job. The department's values just really align with my own because it's a very holistic department. They value community.
2	7	So I took (two peers). We all went and did it. And we all liked it a lot, and learned a lot of great things. Just great things.
2	8	(a peer helped) to analyze my last midterms.

Note. The n value references an interview utterance from specific excerpts for interpersonal relatedness. R = researcher response and P = participant response.

There was a culture of interpersonal relatedness in Case 2. A Case 2 participant explained that they went to one peer for exam analysis, one peer to talk pedagogy, and another peer for material and content questions (Table 4, U = 6). In Case 2, this group

had experienced workshops together where they talked and collaborated afterward, including writing education-related grants after PD opportunities (Table 4, U = 7). Through peer mentorship, Case 2 participants were encouraged to have reflective teaching practice and to write course improvements down after each course (Table 4, U =5). Case 2 participants often allowed access to their online course system to faculty peers, tutors, auditors, and department chairs. Case 2 participants also acknowledged a culture where they talked to peers but also invited peers to come to observe their class. The perceptions around peer talk were coded for using the EVT framework. The specific EVT values themes will be explored in the next section.

Detailed Value Themes

In the Expectancy-Value Theory (EVT), there is the ability to succeed at a task and the value you place on that task. A list of the values are found in APPENDIX D. In this study, the task was focusing on teaching using evidence-based practices to enhance classroom learning through engagement and student voice. Value of a task was also associated with cost because humans conduct a cost-benefit analysis for many decisions (Finielli et al., 2014; Adler & Posner, 1999). Upon inductive analysis of the data, this study added two new values to the EVT framework. One was the value placed on engagement (EV), and the other was the value of content coverage (content). The "content value" was used to explore how much the valuing of coverage of content within courses motivated teaching decisions. The "engagement value" was used to understand if participants valued the interaction or engagement that comes with using evidence-based teaching. All of the value codes were explained in the methods, and the main value themes are explored next.

The Value of Classroom Voice

The values that influenced the inclusion of student voice in the classroom were valuing time, valuing coverage of content, and the perceived utility value of classroom voice. Case 1 participants cited time (12%), content (11%), instructor's voice is valued (5%), and student voice is valued (3%) as significant values in the interview data (Figure 16). Case 2 participants cited time (8%), content (5%), instructor's voice is valued (5%), and student voice is valued (26%) as influencers in motivation during the interviews (Figure 16). The classroom voice values (IVV and SVV) were previously combined into the Expectancy-Value Theory's utility value and attainment value depending on the study (Finelli et al., 2014; Matusovich et al., 2014). The assumption made was that the use of the instructor's voice versus student voice was more efficient for covering content, time, and achieving tenure and was related to the expectancies for success. Student voice value (SVV) was mentioned with less than a 3% frequency distribution for Case 1 and was a significant value them for Case 2 with SVV having a frequency distribution of 23% (Figure 16). The participants in Case 2 stated many times that an emphasis on instructor's voice left students sitting passively (Table 5, U = 2, U =5).

Table 5

The Value of Student Voice

Case	U	Participant Excerpts
1	1	I try to get my students to interact and contribute ideas to their group just to help them feel their ideas are worthwhile.
2	2	They're just sitting there passively looking for the next thing to memorize. And now you're putting them in a situation where that's not going to help them at all. I think those are the motivations for doing it that way.
2	3	I'm pretty clear. An important part of science is being able to talk to others and share your ideas. So, you do not need to be worried about being wrong. Or embarrassed by being wrong. It's just part of being a scientist.
2	4	So that when I ask the students on an info sheet at the beginning of the quarter, how do you learn? Visual, auditory, or kinesthetic? They usually say, they almost always say, visual. That's included. But many of them say all three. So they want all three. I mean it does not work for them just to hear me go blah, blah, blah and show slides.
2	5	I'm learning this stuff really well, but they're not doing the learning. They're being passive. They do activities, I ask them questions, we have discussions. It's not nearly as neat a package. It's just all over the place. But they're the ones who have to put together the knowledge construct. This is not me. I mean, I cannot hand them my knowledge construct and say, here you go.

Note. The U value references an interview utterance from specific excerpts for student voice value (SVV). R = researcher response and P = participant response.

Case 2 participants valued students' voices because talking about science is what scientists do (Table 5, U = 3) and that being wrong was a part of being a scientist. Case 2 participants emphasized students working through problems and experiments versus memorizing content (Table 5, U = 2). There was a sense that students should have ownership over the learning of content (Table 5, U = 5) because they already have access to the content on the Internet (Silverthorn, 2006). They felt it was important for students to learn how to navigate the content to understand what is accurately sourced material.

Participants in both cases stated that students needed more help navigating the content on the Internet and that the instructor's role was to bring the appropriate content to the classroom. Many Case 2 participants stated that students in large classes should be using class time to verbalize their understanding of the content and exploring experiments, whereas, most Case 1 participants were unsure if allowing for student voice in larger classes would even be possible. One of the main reasons cited by Case 1 participants was the time needed to teach larger classes.

The Value of Time

Lack of time is often presented as a barrier in any discipline. Engagement with any activity takes time, and often more time if the activity is new. Time was cited as a cost value in Case 1 about 12% of the time and Case 2 suggested time was a cost value with an 8% interview code frequency distribution. A participant in Case 1 felt like active learning and engagement strategies required more time when they felt research should be where they spend their time (Table 6, U = 1). Some of the Case 1 participants thought that active learning required more time grading and an example of this is in the Table 6) excerpt (n = 3). This person further described that they had used active learning activities but only in small classes. This Case 1 participant said they could not imagine grading a mini-assessment such as an exit ticket or index card for more than 75 students.

Table 6

The Value of Time

Case	U	Participant Excerpts
1	1	If I sacrifice too much of my class time to let them play around with things, I cannot ensure there're the proper proportion of them that are motivated and self-guided enough to most efficiently use that time that I've made available.
1	2	Active learning and engaged practices, is way more time and effort with material while you're doing research.
1	3	In some cases these activities that we do, it's hard for me to justify the time of collecting them, grading them, and handing them back.
1	4	I have not dedicated the time to really put into practice what I think is actually done.
2	5	It's just unrelenting when, you know, every Sunday you're preparing a lecture, and you're preparing three lectures a week and you still have to do office hours, and respond to students, and it's just, you know, it's that much more work. That's why people do not like to do it.
2	6	Once people are on the ground, if they want to make a change in their teaching, it's a major investment.

Note. The U value is there to as a reference for an utterance for time as a cost value.

In Case 2, a participant described that people needed to set up a research lab and get off the ground running. Teaching was a significant investment competing with research lab time. Another Case 2 participant described (Table 6, U = 5) how creating lectures on the weekend has already taken up much time along with the other major duties of communicating with students and hosting office hours. These excerpts align with other studies on faculty motivation where faculty say that learning new practices or transforming an existing course takes time (Finelli et al., 2014). The use of faculty time in class is also related to how they prioritize the value of coverage of content, another major value theme.

Table 7

The Value of Content Covered

Case	U	Participant Excerpts
1	1	A lot of people are going away from content and that there's just a certain amount of content that you've got to cover, if not, nothing else works.
1	2	I try to cover the topics that the American Society for Microbiology recommends gets covered. My job is to prepare you with material that will likely succeed in upper-level classes.
1	3	You can certainly use some approaches and dig deep into and do well with some material but the flip side of that is you also do not cover as much material.
1	4	It's a big role, if I had to give it a percentage I'd say like 80 to 90 percent, I feel like I have to cover these topics to give them true coverage of that topic. I do not want to leave anything important out, I guess I'm afraid of shorting the student of some information.
2	5	R - There seems to be a value of covering a certain amount of content. You want to give them the whole canon. P - Right. R - So why is that? What is it about the covering of the content. P - That I think is important.

Note. The U value references an interview utterance from specific examples for content. R = researcher response and P = participant response.

The Value of Covering the Content

Participants were asked what role covering content played in their teaching practice. Case 1 participants mentioned coverage of content 11% of the interview transcripts and Case 2 participants mentioned content coverage about 5%. Case 1 participants mostly agreed that covering a certain amount of content was a significant motivation for how a course was designed (Table 7). One participant said content

coverage played an "80 or 90 percent" role in course decision making (Table 7, U = 4). There was a perception that using evidence-based teaching required not just more time but took away from the content covered for Case 1 participants (Table 7, U = 1, U =3) and with one Case 2 participant also agreeing with this claim (Table 7, U = 5).

The message from Case 2 participants overall was that they try to cut away content every time they teach a course and focus on learning outcomes that align learning expectations for future upper division courses. Both cases had this in common, the idea of wanting to prepare students for upper division classes (Table 7, U = 2, U =4). Faculty communicated the importance of honoring their place in the curriculum of the major offered. Honoring a place in the curriculum suggested faculty understood their role in the larger biology curriculum and that they valued their responsibility of covering the content within the broader curriculum. This study explored the value of role by also looking at the attainment value.

Attainment Value

The degree to which a task is consistent with one's self, attainment value, was one of the primary values in the original EVT framework. For this study, it was essential to understand how self-identity aligned with the task of trying evidence-based teaching. Three new codes were used in the EVT framework to explore the attainment value and self-identity: self-identified as a researcher (SIR), self-identified as a teacher (SIT), and self-identified as both (SIB). SIB was coded when participants identified as researcher and teacher in the same sentence or indicated they saw their job as 50% research and 50% teaching. Participants were asked how they identified on a continuum from a researcher to a teacher.

Case 1 participants mentioned an attainment value with a frequency of SIR (12%), SIT (5%), and SIB (1%) and Case 2 participants with a frequency of SIR (8%), SIT (5%), and SIB (23%) (Figure 16). Case 1 appeared to have a climate where participants often identified as a researcher first. Often the Case 1 participants who identified as a teacher were later in their career, mainly teaching at that point. In Case 2, many of the participants, when asked about how they self-identify would say that they loved research but had chosen this department because it was a community that valued teaching (Table 4, U = 6). Case 2 had created a climate where faculty felt comfortable self-identifying as both researcher and teacher. The job requirements for the role of researcher and teacher are essential in the academic tenure and promotion process. The value that faculty placed on achieving tenure was a major value theme for Case 1 and often mentioned in Case 2.

The Value Placed on Achieving Tenure

Case 1 placed a high value on achieving tenure (AT). Participants indicated it was a reason for focusing less on teaching and more on research. The participant excerpts sum up a clear theme in Case 1 participants' views on achieving tenure as it relates to teaching and research (Table 8).

Table 8

The Value of Achieving Tenure and the Task of Teaching

Case	U	Participant Excerpts
1	1	You just need to do your research. That's where you're going to be valued and evaluated for tenure, and you just do whatever you have to do to teach your classes. You just be a carbon copy of them.
1	2	Tenure is going to come, in the sciences, from your success publishing and grants and that's the only thing that really matters.
1	3	But if your score (teaching evaluations)is lower than the departmental standards and you've got 3 publications and you've gotten $500,000 grants then you're getting tenure.
1	4	I think the committee and the chair and the dean just want to see that you're doing a good job teaching. But they really weigh more heavily are you publishing papers, are you driving the research program, are you trying to get funding.
1	5	But anyone pre-tenure right now, the main focus is research and very little on teaching.
2	6	How it works here and probably at most R1 universities is that if you're getting your grants, and you're doing a minimally confident job in teaching you're going to get tenured.
2	7	And there are certain faculty who send a very clear. Just be adequate, get your research going. You know, focus on research. Focus, focus, focus. And research is, But, I, I guess my point was, there were faculty members who are sending the message that teaching matters less.

Note. The U represents an utterance from a participant that was coded as the value of achieving tenure.

Often new faculty were told to get the course materials from their peers and to maintain the teaching status quo of using traditional lecture (Table 8, U = 1). Case 1 participants indicated that they perceived that this culture of placing more value on research versus teaching to achieve tenure was typical of a modern science department. This group indicated that their department chair and dean fully supported a focus on

teaching; however, promotions were often rewarded to faculty members that received internal or external funding and had research publications (Table 8, U = 5). A few Case 1 participants indicated that they believed that peers with high-quality research and with low-quality teaching could get promoted.

Case 2 participants also felt that research was valued over teaching in their department. However, they indicated that someone who demonstrated low-quality teaching would likely not get tenure in every case. It appeared that Case 2 was in the middle of a climate change in the department in that a movement to adopt evidence-based teaching had begun. Some seasoned faculty members communicated that research was valued more than teaching. However, the mentors assigned to new faculty all held a belief that teaching and trying to engage students as scientists were important (Table 8, U = 6, U = 7). The Case 2 mentors modeled the use of evidence-based teaching in the classroom. In Case 2, participants felt they needed to establish an excellent research program, secure funding, publish, but also focus on quality teaching and student learning.

These findings on how achieving tenure might affect teaching were aligned with the factors for engaging in the research-practice cycle (Matusovich et al., 2014). The time it takes to engage with a teaching practice is a cost to research and achieving tenure (Matusovich et al., 2014). If there is interest in having faculty engage in evidence-based teaching, then it must also be valued in the tenure process. This idea of what tenure documents can communicate is related to the perceived value of autonomy aligned with academic freedom.

The Value of Autonomy

Autonomy is the freedom to choose what one might value and perform out of interest or personal importance (Black & Deci, 2000. Case 1 had mentioned autonomy 5% of the interview transcripts, and Case 2 was 1%. However, investigating autonomy as a motivator provided insight into the coverage of the content theme. The faculty members in Case 1 felt they had the autonomy to teach and cover the content they wanted to cover within a particular class (Table 9, U = 1, U = 2).

Table 9

The Value of Autonomy

Case	U	Participant Excerpts
1	1	We're given complete freedom to approach our classes the way we want to.
1	2	I have some freedom in terms of what I want to have covered.
1	3	It was not wanting to go to industry and also with being able to chart my own course.
2	4	They do not want to be told what to do. And I do think that, um, when you pass down guidelines, rules, etc. You know, if they come up with it, then I think there's a sense of, this is my idea, I can embrace it.

Note. The U represents a segment that was coded as the value of autonomy.

Some participants in Case 1 described that they chose academia because they valued autonomy in their professional lives (Table 9, U = 3). A participant in Case 2 described that faculty members are attracted to a work climate that does not "tell them what to do" and they are more likely to embrace evidence-based teaching if there were no

job requirements in place (Table 9, U = 4). This participant was alluding to a climate of autonomy that exists in academia, a culture of independence and academic freedom (Cox et al., 2011). Professional development (PD) may be more successful if the importance of autonomy is considered depending on the context of each group of PD participants. The usefulness of professional development, talking to peers about teaching and evidence-based teaching tasks are discussed in the next section.

Utility Value

The utility value in this study was defined as the perceived activity usefulness. The activities considered in this study involved teaching, professional development, access to experts, and talking to peers about teaching. The interview transcripts were coded as Use+ for statements that showed participants valued these activities and Use- was used for when these activities were not valued. In Case 1, there was a frequency distribution for USE+ with 10% of utterances and USE- with 3% of the interview utterances. In Case 2, there was a frequency of 23% for USE+, and zero statements were coded for USE- in the interview code data.

Table 10

Utility Value - The Usefulness of Teaching, PD, and Talking to Peers About Teaching

Case	U	Participant Excerpts
1	1	R - Do you think other people in the in that department are talking about their teaching practice for their peers? P - I've never thought about it. I do not my answer's not going to be based on evidence, but if I had to assume an answer, my assumption would be no
1	2	No, I know some people do, and I have occasionally asked people for help, like what, what do I do with clicker responses. You know I feel like some of our best resources are the education faculty.
1	3	Not much. Um, the only person I've talked to about teaching practice is (a peer).
2	4	We all did get together a while back and talked about what we, what we considered core concepts.
2	5	So it feels like there's a lot of opportunities to try to have an impact, on a, on a broader community. Okay, so there was a workshop, and I began to see, oh I can create particular lessons. And, then, I went to the Summer Institute. And I had to take a bunch of teachers from (the university). They wanted you to come as teams. We all went and did it. And we all liked it a lot and learned a lot of great things. Just great things.

Note. The U value references an interview utterance from specific examples for utility value. Some of the excerpts are from the direct question, "do you talk to your peers about your or their teaching practice?" R = researcher response and P = participant response. (a peer) is a specific peer mentioned.

Generally, when asked if Case 1 participants talked to their peers about their teaching practice the response was "no," "sometimes," and "perhaps only one person" (Table 10, U = 2, U =3). Some Case 1 participants described a need to communicate more with peers and experts. One participant indicated that access to professional development experts in the department was underused (Table 10, U = 2) and that she had tried to talk to peers about clickers. Her excerpt spoke to the need for better communication to foster a climate focused on talking about teaching.

In contrast, there were many conversations with Case 2 participants describing faculty attending workshops together and creating change plans following the workshops. In Case 2, the activities of talking to peers about professional development were valued and utilized (Table 10, U = 4, U = 5). The utility value data aligns with different themes of communication with peers, students, and administration that existed between the two cases. To understand these different communication climates, the next section moves from examining the intrinsic moderator of motivation (as viewed by EVT) and explains the external situational conditions of each department case that might influence the use of evidence-based practices.

Part 3 - Case Situational Conditions

What situational conditions support science faculty motivations for focusing on teaching practices based on evidence?

This study explored the departmental climates, policy documents, mentorship models, teaching awards, and communication strategies to understand the supportive/unsupportive situational structures of each department case. This dissertation assessed each department's climate because climates consist of the work experience essentials that faculty require to be motivated and successful (Gappa et al., 2007). The shared policies and communication within a department make up the climate and help faculty assign value to job tasks like teaching (Ostroff et al., 2003; Schneider & Reichers 1983; Schneider et al., 2011). Communication between individuals in each the case departments was explored in each mentorship model as well.

Department Cases' Faculty Mentoring

Through the coding process for expectancies and values, the concept of mentorship frequently emerged because it aligned with the expectancies of interpersonal relatedness and self-efficacy. Mentorship also aligned with the EVT framework values of interest and utility value. The two models of mentorship were explored in each case along with the results and how they align with the EVT expectancies and values.

Case 1and Case 2 departments both assigned a mentor to all new faculty when they began their employment. In Case 1, the collaboration of mentor and mentee is viewed as mentee driven (Table 11, U =1). One member in Case 1 said it was more of an email relationship where one could ask questions or ask for resources such as lecture materials. Another participant in Case 1 said they did not buy into the mentorship model as they felt senior and junior faculty should self-select into a mentorship relationship, and a third participant said the solicitation of mentoring rested with the new faculty mentee (Table 11, U = 2). This person did not find mentorship useful (utility value) and stated that mentoring should be a self-selected process versus assigned mentorship.

Table 11

Case Mentorship Models

Case	U	Participant Excerpts
1	1	I'm probably not as proactive at being the mentor to approach the mentee and say, it's time we have a talk! How is everything going? I'm a resource that that person can draw on if needed, and I let it be mentee-directed in terms of timeframe.
1	2	Everyone is assigned a mentor, personally, I think assigned mentors are ridiculous, but it's the thing, that's what we do in higher ed now, you get assigned a mentor. A fruitful mentoring relationship is one that develops when there are two people who realize that they have some kind of common ground.
1	3	Mentoring is like the yah know, all the universities are talking about it. It's a way to give administrators, something to put on their checklist.
2	4	I was like, okay, this percentage of the time is being spent on questions, you know, I can see that he's like checking the room here, like I can see, you know, the examples he's using are examples like related to (sic) …and that seems to wake them up. I've sat in on a couple other lectures just to sort of watch the meta of their room.
2	4	In our department we've had a few people like that. And we've always just gone in and kind of mentored them pretty intensively for a year or two after.
2	5	I co-taught a grad class and I co-taught molecular biology. It's formalized at least the level of the department where every new professor co-teaches. And you have senior faculty who are willing to and its more work for them to co-teach. …taking half the teaching credit for basically being in the class the whole time. Like it's not like he just showed up half the time. Both of us were at every single lecture.

Note. The U value references an interview utterance from specific examples of mentorship. (a peer) is a specific peer mentioned.

In Case 2, the department had a clear policy that says all new faculty must co-teach with a seasoned faculty mentor for the first year of employment (Table 11, U = 5). For triangulation purposes, there was a follow-up with the newest faculty in Case 2, and they did spend the first year co-teaching every class with a seasoned faculty member.

New faculty members from Case 2 stated that the mentorship model was useful (utility value) and they were enjoying being mentored (attainment value). New faculty members were encouraged to observe other peers' classes. The Case 2 mentorship model allows for a climate where observing another faculty in class is normative and welcomed. One participant observed a mentor and learned how to check the room for student engagement and understanding, the types of questions to ask students, and the use of examples that were relevant to students to keep them engaged (Table 11, U = 4).

A Case 2 participant explained that each faculty member gets half the credit for co-teaching. Teaching load is highly valued, yet Case 2 faculty members were willing to buy into the co-teaching model even if they received half the credit for a whole class. Another participant in Case 2 described what happens when and if a faculty member struggles with teaching later on in the tenure and promotion process (Table 11, U = 4). It is standard practice to mentor struggling faculty after the "new faculty" period and helps support growth towards better teaching. The Case 2 co-teaching model also motivated new faculty to interact with students and peers. New Case 2 faculty were encouraged to attend tenure and promotion meetings and learn about the promotion process.

Tenure and Promotion Policy Communication

The department cases' tenure and promotion policies were analyzed in Nvivo for themes using a word frequency query. Case 1's tenure policy had a frequency count of "teaching" (8%), "research" (22%) and Case 2's tenure policy had a word frequency for "research" (19%) and "teaching" (16%) (Figure19). "Research" was one of the top words in both departments' tenure and promotion policies. The teaching expectations were more frequently mentioned in Case 2's policies. Department Case 1 appeared to emphasize

"presenter effectiveness" with a frequency count for "presentation" (5%), "lecture" (3%), "PowerPoint" (1%), "education" (1%), "students" (1%), and "learning" (0%) (Figure19). The policy appeared to be communicating a teacher-centered expectation for the teaching part of tenure and promotion. The policies from Case 2 emphasized research and teaching with the frequency of the words for "student" (14%), "knowledge" (4%), "lecture" (1%), "education" (3%), "learning" (1%), and "PowerPoint" (0%) (Figure19). The language seemed to emphasize student learning as a goal and appeared to be more student-centered. Case 2 policies had a lot more language about teaching and expectations for quality teaching. One of the teaching measurements communicated in the Case 2 policies that teaching awards were evidence of quality teaching.

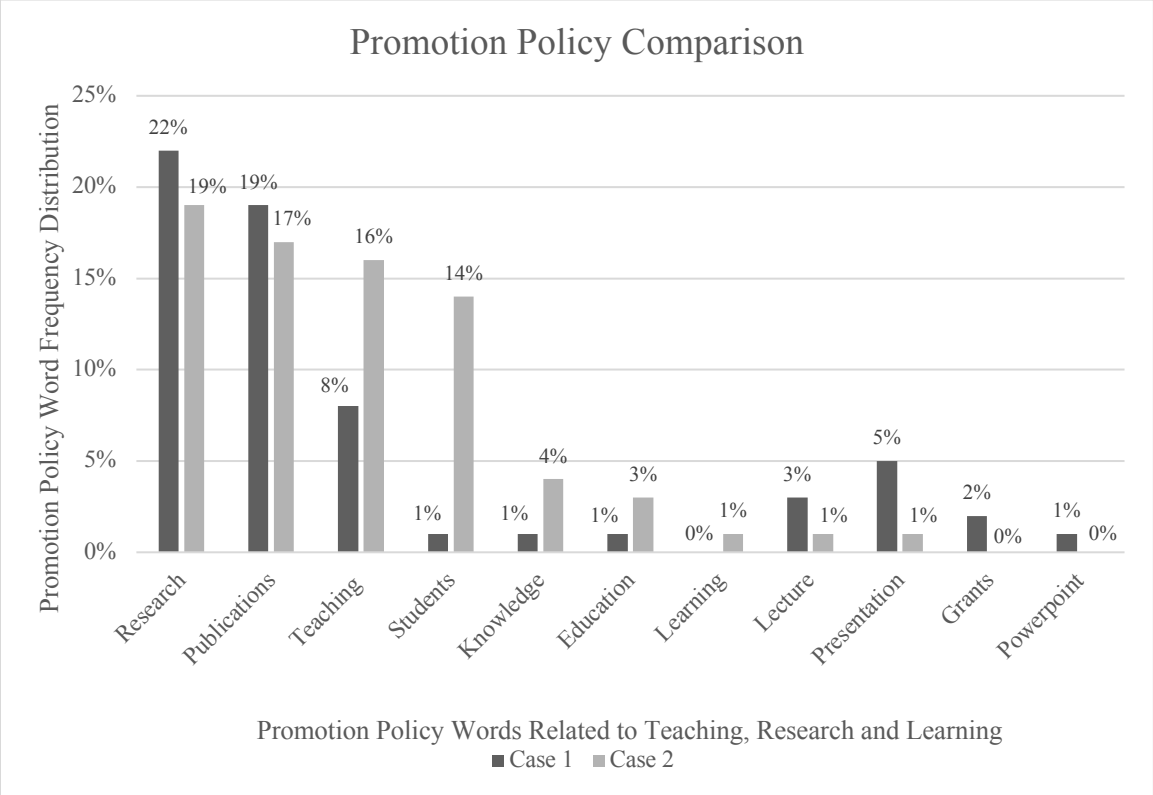


Figure 19. A comparison of the cases tenure and promotion policies by word count frequency.

Teaching Awards

Teaching awards data was collected from the department tenure and promotion policies and public records. Nvivo was used to analyze department cases' tenure and promotion policies for what was communicated about teaching awards. The promotion policies in department Case 1 did not communicate any language or expectations when it came to awards for teaching. In department Case 2, the promotion policies stated that teaching awards were considered "evidence of teaching effectiveness" and awards were mentioned many times as evidence for a strong promotion dossier.

The university teaching awards data were taken from the most recent ten years. The percentage of awards presented was calculated and divided by the total awards received by the biology, math, chemistry, and history departments in each case. Case 1 received 1.3% of the possible teaching awards given over the last ten years compared to the department of mathematics (5.19%), chemistry (1.30%), and history (2.60%). Case 2 was awarded 7.94% of the teaching awards given by its university for over ten years. At Case 2's institution mathematics has received 6.35%, chemistry 7.94%, and history 11.11% of the teaching awards during the same period. While there was not a large enough sample size to suggest there were an apparent cause and effect relationship, this study notes that the promotion policies of department Case 2 state that teaching awards were evidence of quality teaching and this department has won 7.94% of the awards compared to department Case 1 that has won 1.3% of the possible teaching awards.

Student Evaluations

Case 1 participants stated that student evaluations focused on lecturing, PowerPoint organization, and instructor tone of voice. The communication in the student

evaluations aligns with what was communicated in the Case 1 tenure policies with an emphasis on "presenter effectiveness." Case 1 indicated that the evaluation did not take into account if one were good at creating experiential learning opportunities such as taking students into the field or training them in a lab to do undergraduate research.

Case 1 participants indicated that the student evaluations were essential and they had developed strategies to increase their student evaluation scores. Case 1 participants indicated that student evaluations were used and reviewed but that the perceived climate was that research was a priority. One participant in Case 1 in their interview described being told to continue with the teaching status quo of a traditional lecture. One participant said that he had learned to augment when they scheduled the student evaluations around the timing of exams given. Participants in Case 1 stated that they had learned to tailor their class to the measurements on the student evaluations. One of the measurements on the student evaluation at department Case 1 says "Made me work harder than in most other classes." This is not a good indicator of effective teaching if the intention of the course is not to be hard but, for example, to teach students specific study skills for achieving a science degree. This kind of measurement may communicate to the instructors that every course they teach should be harder than all the other courses that students are taking in that same semester.

In Case 2, the student evaluations rarely came up in any of the interview conversations. The Case 2 evaluation focused on instructor helpfulness, respect for students, learning experience, clarity and understandability, the quality of feedback, and overall instructor effectiveness. There was no mention of tone or presenter effectiveness language. Most Case 2 participants did not mention student evaluations. Student

evaluations were stated as a measurement for effective teaching in the Case 2 policies. However, it was not the only or main measurement of instructional effectiveness. The Case 2 climate of focusing on student thinking and learning aligned with the communication in the student evaluations. This next section considers the overall communication between individuals in each of the department cases given the evidence from policies, evaluations, mentorship models, and teaching awards.

Departmental Communication

Many Case 1 participants responded that they did not talk to peers about their teaching practice and if they did talk to someone, it was likely only one peer. In Case 2, all participants interviewed said they talked to their peers about teaching. One participant described going to specific peers for each of his teaching practice needs. Overall there is an environment in Case 2 of talking to peers about teaching.

In Case 1, the participants reported that the department chair and dean have said they support teaching. However, the tenure policies and the promotion history suggest the environment will likely promote Case 1 participants that focus on research. Many Case 1 participants felt that their peers could establish a high-quality research program and be a low-quality teacher and still get promoted. In Case 1, the promotion meetings and voting were held without pre-tenure faculty members which align with most higher education department practices. In Case 2, the department chair and dean both stated they supported teaching. Case 2 participants agreed and confirmed their support. In Case 2, all pre-tenure and tenured faculty were allowed to sit in on all promotion meetings. The Case 2 department stated that this policy allows for better communication on expectations for achieving tenure.

The climate constructs of each department case were measured and gave a baseline for some of the situational context of each department case. For the most part, both departments seem to have a similar climate when it comes to resources, collegiality, respect, professional development, and autonomy. The situational environments for each case left faculty with different expectancies and values for the task of teaching. There were communication barriers between peers and the administration in Case 1. The values placed on the task of teaching and communicating with students showed a climate that might lead to less student classroom voice in Case 1.

In Case 2, the environment seemed to support a climate of talking to peers about teaching and supporting student voice in the classroom. This climate of communication will be further discussed in chapter V. However, this research-to-practice problem is complex and requires more than better policy communication and measurements. One of the ways to address the research-to-practice gap in higher education science may be related to institutional environments and structures (Beach, Henderson, & Finkelstein, 2012; Henderson, Beach, & Finkelstein, 2011). However, a focus on institutional environments is not enough, and this next section explores what participants said would need to change in order to adopt evidence-based teaching.

Part 4 – Change

What do science faculty members perceive would have to change in their department or within themselves to adopt evidence-based teaching that prioritizes students' voices?

Participants were asked what changes would need to happen as it relates to motivation to see a movement towards evidence-based teaching. In Case 1, many said the

student evaluations did not align with teaching expectations, and they would need to change to align with evidence-based teaching (see the previous section).

Addressing Evidence

Many participants in Case 1 explained that seeing the success of evidence-based teaching was necessary for creating change. This makes sense as the need for evidence was a key expectancy described by Case 1 participants in the interviews. One participant said the value of student voice in the classroom needed to be demonstrated (Table 12, U = 1). A Case 1 participant said the student experience motivated him, that if students communicated, they did not have the tools needed to graduate, this would spur change for him (Table 12, U = 12). This participant suggested that a feedback process from upper division students would be helpful.

Table 12

What do science faculty perceive would have to change in their department or with themselves to adopt evidence-based teaching?

Case	U	Participant Excerpts
1	1	If a faculty member can see the value of student talking, I think that will motivate them to do it. It has to do with the value, and if you can show that value, that may be all it takes, but um, well that value in contrast to the value they see their own words have.
1	2	If I felt that students come out of my class, did not have the tool to be successful in their upper division classes, then I would want to make change. So, maybe an answer is if they have some kind of feedback, there is no mechanism for a junior student to say I did not get or did get what I needed in your class.
1	3	I think that um, to really hold their hand through it, you know like to, to go to the class with them and talk about you know why this might not have worked or why this, this was starting to work, but then oops you know something happened and you know I think, that kind of stuff would be super valuable. People would really appreciate that individualized assistance. I think would be really beneficial, and I know there's a lot of faculty who would really be excited about that.
1	4	so if you are not good at lecturing then you are not going to be good at the student evaluations.
1	5	You must not try to convince them that you're right, you need to show them, in the way that they're used to be shown in, in a way that's evidence approach, people approach that in different disciplines, different ways. Really difficult to connect to other sciences, unless you're talking to them in the way that they've been trained.
2	6	So, there's just this huge time barrier. So, you know, one thing is to give people teaching relief. To redesign a class.
2	7	...like the faculty has to be motivated to do it in some way, right? Um, and, you know, that goes back to something like hiring for, you know, promotions, for example, and maybe the extent to which (the tenure committee) or whoever it is, cares about teaching.
2	8	Incentivizing it. So I guess this means extra stars at promotion. Tenure teaching expectations are that you can do a medium job teaching as long as you are a very good/ excellent researcher.

Note. The U value references an interview utterance from specific excerpts for this question.

This was an insightful exchange that was too big for Table 12 but summarized some of the ideas for how to motivate faculty to adopt evidence-based teaching. P is for participant and R is for the researcher.

P - I really do not know. I think if you could get, um, if you could get the class more interested in what is going on, I think that would help. I think that some sort of interactive thing were you say well what all do you think.

R - Right. But you think it's only doable in smaller classes.

P - Well. It might be doable in a large class but I think the effect is only for small groups.

R - So, you think the ability is there. You think that faculty are capable of engaging or trying to engage, create engaging strategies in large lectures but the effect of those activities would only be useful to small groups in that large lecture.

P - Right.

R - So you think some things have to happen from a policy standpoint to change the quality of teaching, or the motivation for teaching?

P - Right. Some sort of policy.

R - Right. Is there anything we can do like at a individual level to help individuals one on one.

P - We've tried all sorts of things and I, I really do not know other than ... than again maybe a, a switch, um. I do not even know if a switch would be the correct word for or the correct thinking of it. But basically, some sort of change where teaching would be important. If you've done a good job teaching, you know, that

would be counted in toward, toward tenure and promotion the same as the research.

R - Yeah. If you do not count it, if you do not measure it and it does not get counted it does not get valued.

P - Exactly.

This participant from Case 1 expressed that class size needs to be addressed to create change. He felt more than confident in creating interaction in small classes but not larger classes. He also said if teaching effort does not count towards promotion, then it will not get valued. Many participants in both cases said if one wants faculty to value teaching, then it has to be a more significant part of the promotion process (Table 12, U = 7, U = 8). This aligns with one of the significant motivation component findings, that what gets communicated in policies and through the promotion process was a significant motivational influence. A summary of this study's findings will be discussed in Chapter V.

Study Limitations

One of the significant limitations to statistical generalizability of this study was respondent size (n = 28) and only two case departments. The goal of the study was to provide an understanding of faculty motivation. There was a lack of consistency for the level at which tenure and promotion policies are created. This was evident in this study because the tenure and promotion policies in department Case 1 were department specific. In department Case 2, the tenure and promotion policies were for the entire university. This was a limitation because of the level, university-wide versus department specific policies, at which these documents were being analyzed were not the same.

In the survey, there was an error in a question that asked: "Do you talk to your peers about teaching?". This question should have said, "Do you talk to your peers about your teaching practice and what does that look like?" The limitation here is that participants may have been talking about teaching as it relates to students, teaching load, etc., that may not be related to teaching practice. The neglect of that word "practice" meant that there were limitations to any interpretation of that question. The researcher followed up in the interviews to clarify and ask the participants about their peer discussion in regards to teaching practice. However, not all participants from the survey were interviewed so this question was limiting. Follow-up questions were insightful and added to a clear distinction between the cases and the amount of communication in each department. These results are explored further in chapter V and were used to design modified EVT models and a new professional development model.

CHAPTER V: DISCUSSION

Introduction

The most common teaching practice in America's universities is lecturing (Mazur, 2009; Pascarella & Terenzini 2005; Eagan, 2016) and this study investigated faculty reasons for continuing this practice in their particular departmental contexts. One reason for this inertia may lie in the existing hiring and training practices in higher education. Biology faculty members are often hired from graduate school with no pedagogical training (Sunal et al., 2001). Tenure and promotion are usually based on research, publications, and grant writing (Tanner & Allen, 2006). Using evidence-based teaching and active learning is not required to achieve tenure in many research-focused colleges and universities. Active learning strategies under a student-centered model have been shown to be more effective than lecture but are still slow to be adopted nationwide (Freeman et al., 2014; Michel et al., 2009; MacDonald & Frank, 2016). A transmissionist view prioritizes the most commonly used pedagogical practice of lecturing (Pampaka & Williams, 2016; Stains article from Science, 2018).

Faculty members continue to stay with this transmissionist, teacher-centered approach (Hurtado et al., 2012). Despite the evidence, the engagement in the research-to-practice movement has been slow and complex (Henderson et al., 2011; Henderson & Dancy, 2011). Evidence-based teaching using active learning strategies increases student learning and thinking (Bonwell & Eison, 1991; McKeachie, 1972; Felder et al., 2002). These approaches emphasize student voice, therefore, reducing instructor voice to improve student cognition (Michel et al., 2009). This study set out to understand faculty motivation to continue a practice where students are passive note takers in undergraduate

biology classrooms (Tanner, 2009, Eagan, 2016). This study wanted to understand what would it take to motivate faculty to adopt evidence-based teaching and increase student voice in the classroom. This chapter begins with a summary of the study findings and describes the significant implications of this study. Chapter V also describes the major findings in each case and how they were used to build specific visual EVT models. Finally, Chapter V describes the importance of measuring classroom voice data and proposes a new model for thinking about professional development in science higher education.

Summary of Study Findings

Initially, the case participants appeared to have in place similar perceptions on the climate constructs of resources, respect, collegiality, autonomy, and professional development in their departments. However, the climate of a department was not an indicator for the motivation to adopt evidence-based teaching, given the lack of statistical significance from the climate survey and the evidence of clear situational condition differences in each case. This research revealed differences across department cases in promotion policy, communication amongst peers and students, mentorship models, and expectancies and values.

One of the significant differences in the two cases is the structure of the initial teaching support for new faculty. In Case 1, new faculty members were assigned a mentor but in a mentee driven model where it is often incumbent upon the mentee to reach out to the mentor. In Case 2, the support for novice instructors came from a co-teaching model. There was motivation to engage with peer and students in both cases.

However, Case 1 participants indicated that peer communication could improve. Case 1 participants described a climate where there were less peer and student interaction.

Case Comparison Summary

	Case 1	Case 2
Research focused policies	Yes	Yes
Teaching focused policies	No	Yes
Mentorship Models	Mentee driven	Mentor driven
Observation Culture	No	Yes
Communication Climate	Low	High
Resource Sharing	Limited	Yes
Content Coverage	High	Low
Identity	Researcher	Researcher & Teacher
Student Voice Present	Depends	Yes
Classroom practice	Teacher-centered	Student-centered
Ability to Succeed at EBT	Low	High
Value for EBT	Low	High
Motivation to adopt EBT	Low	High

Figure 20. This is a modified model interpretation of the EVT theory for department Case 1 based on case analysis in this specific context.

In Case 1, there was an emphasis on a teacher-centered model of presenting content, and in Case 2 teaching was communicated in a way that motivated those participants to adopt evidence-based teaching practices. The classroom voice data indicated a teacher-centered climate in department Case 1 and openness to student-centered models in department Case 2. The classroom voice data suggested that student

voice might be sacrificed in a large classroom so instructors can be efficient at covering content in Case 1.

Using the expectancy-value theory as an analytical framework allowed a more in-depth look past climate to participants' expectancies for success and valuing of teaching. Department Case 1 indicated that there were some barriers with their expectancy for success with large class size and the perceived lack of evidence for EBT being primary. In Case 2, the strategy for many participants was to slightly modify the EBT strategies they used in small classes to be more appropriate for larger classes, hence reducing some of these perceived barriers.

The cases were similar in how they viewed research, promotion, professional development, and engagement and interaction. Both departments had interest in evidence-based teaching and interpersonal relationships, and valued engagement in their roles as teachers and peers. Participants in both departments felt confident in their abilities to facilitate evidence-based teaching strategies such as group discussions. Both department cases had a center for teaching and learning on campus that regularly provides professional development opportunities through workshops, professional learning communities, and teaching fellowships.

Both department cases' policies communicated that research is a priority in professional advancement. There were differences in the teaching expectations communicated to faculty in each department case. In department Case 1, the values of achieving tenure, autonomy, content coverage, and control in the classroom were important themes. In department Case 2, self-identification as both researcher and teacher was more prevalent and participants had high self-efficacy for the ability to be

successful with evidence-based teaching. The participants in department Case 2 communicated that they valued student voice and thought evidence-based teaching and talking to peers about teaching was useful.

Case 1 and Case 2 had an interest in evidence-based teaching, felt they had opportunities to engage it EBT, and could participate in interpersonal relationships with their peers, students, and experts. One caveat is that department Case 1 wanted professional development opportunities to be department-specific and on scheduled faculty time. Both departments valued engagement, valued instructor's voice and indicated time was a cost that motivated teaching effort and the adoption of evidence-based teaching.

Both department cases' participants were confident in their abilities and skills needed to facilitate evidence-based teaching. There was a disagreement on the perception that additional teaching effort can affect student achievement between the cases. Student achievement and teaching efforts spoke to how each case department viewed the values placed on teaching differently and aligned with the Expectancy-Value Theory.

Department Specific Motivation Models for Science Faculty

Models for each case were designed using the expectancy-value theory (EVT) as a framework, and it allowed for two evidence-based teaching task questions, "Can I do this?" and "Why do I want to do this?" (Eccles et al., 1983; Wigfield & Eccles, 2000; Finelli et al., 2014). The question of "Can I do this?" aligns with the expectancy or the perceived ability to complete the task. Overall faculty in each case study felt they could facilitate class discussion, engage students, and possessed the skills needed to implement a student-centered model with active learning strategies. When probed on the value of the

task of adopting evidence-based teaching, this research found many internal and external motivators affecting the value placed on the utilization of evidence-based teaching. This next section lays out the major findings in each case and the specific motivation models built from these findings.

Case 1 Major Findings

Class size, credible evidence for the use of EBT, achieving tenure, content coverage issues, and classroom control are vital for future work using EVT as a lens for PD with cases similar to Case 1. Case 1 policies and promotion history did not emphasize teaching, and there was more of a focus on research. Because research is often the primary focus and qualification for promotion, faculty members pride themselves on being world-class autonomous researchers (Boyer Commission on Educating Undergraduates in the Research University, 2002). The last three decades have seen graduate school training focused on training academics to be researchers versus teachers (Fairweather et al., 1996; Boyer Commission on Educating Undergraduates in the Research University, 2002). Until departments reward teaching as much as research, there may exist little incentive to focus on effective teaching (Hannan, 2005; Porter et al., 2006). However, it is easier to change department policies than to improve individuals' beliefs and influence their motivations (Cox et al., 2011).

The individuals in Case 1 believed traditional lecture was the best strategy for honoring their place in the curriculum. Traditional lecture seemed more efficient for covering content in a larger classes in Case 1. Transmission of knowledge in college classrooms through lecturing has been the universal mode since European universities were created (Brockliss, 1996). This time-honored tradition was evident in in Case 1

participants' DART outputs. The volume pattern clearly indicated the use of one voice, that of the instructor in most of the class. When asked, Case 1 participants stated that they valued instructor voice and student voice in the classroom. However, they were clear that if the class were large, they would default to an instructor-voice-dominant strategy such as a traditional lecture. Classroom voice data showed that student voice was surrendered, meaning there was less student voice in a large classroom so instructors could be efficient at covering content. The expectations and norms around coverage of content may be a limitation for evidence-based teaching implementation (Henderson & Dancy, 2011). These participants made a clear distinction between a duty to provide content to lower division students and more freedom to use evidence-based teaching with upper division and graduate classes. Upper division and graduate classes were often smaller and the students were "mature enough" to engage in group discussion. This group also believed that there was less classroom management time needed in smaller classrooms and this allowed for the use of evidence-based teaching. There were clear beliefs around time, amount of content to cover, and classroom management perceptions with Case 1 participants.

Perceived classroom time limitations related to evidence-based practices were a significant barrier that came up for Case 1 participants. Participants in both cases indicated that a focus on evidence-based teaching took away from classroom time and research time. Evidence-based teaching is an investment of more class time. In student-centered classrooms, students are spending more time interacting versus listening to the instructor (NRC, 2012). Case 1 participants identified more often as researchers (SIR) and less often as teachers. Facilitating student interactions requires time to think through

course design which can be perceived as less time for research. Some Case 1 participants indicated they had chosen academia because they would be able to focus on research and that they knew teaching was required. However, their focus was on the research and not the teaching.

The focus on research versus teaching was clearly communicated in Case 1's promotion policies and there was no real emphasis on the importance of teaching related communication as a function of the faculty members' jobs. The lack of importance that faculty perceive to be placed on teaching is common in university promotion policies (Finelli, et al., 2014; Cox et al., 2011). In Case 1, there was less communication with peers, students, experts, the center for teaching and learning (CTL), and the administration about issues related to teaching compared to Case 2. The result indicated less use of science education research evidence in teaching in all classes.

One of the major themes in Case 1 was the need for credible evidence for the effectiveness of evidence-based teaching and an increase in student performance. There may be a distrust of biology education research due to the differences in disciplines but also a general avoidance of the unfamiliar approaches suggested by evidence-based teaching (Handelsman et al., 2004). This is a quote from a participant from department case 1, "Many of us have tried different methods but do not seem to really change student results." It is possible that faculty understand the importance of teaching in their role as academics and have tried to improve their teaching practice but have failed to see the immediate results on student learning (as they define it). Faculty members may have tried some new strategies. Faculty may be more open to trying and failing if they see their peers doing the same but still encouraging the use of new teaching practices (Finelli et

al., 2014). However, Case 1 participants had not seen significant student achievement and did not have a culture of talking to peers about teaching to justify a continued focus on teaching using evidence-based practices.

Case participants overall indicated a perception that an increase in teaching effort did not correlate to increased student achievement. The value or expectations for teaching and student achievement is not clearly communicated in Case 1. Some sciences faculty are unconvinced by the effect of science education research on student learning (Finelli et al., 2014; Cox et al., 2011). Case 1 participants explained that it was important for science education researchers to present education evidence in the same way their discipline presents scientific evidence. Finelli et al. (2014) noted that participants stated credible research evidence as critical to faculty investing in learning new teaching strategies. Plus, teaching effort or a course redesign takes a considerable investment of time. Compound perceptions about individual investment with the teaching effort communicated in Case 1's tenure guidelines and the motivation for adopting evidence-based teaching are low. Class size, communication, identity, and the need for credible evidence were built into the professional development model that would theoretically promote faculty change in Case 1 (Figure 20).

Case 1 Modified EVT Model

This is a model for thinking about the expectancies and values emphasized by the participants of Case 1 (Figure 20). This model mostly hangs on the faculty members' ability to succeed in implementing evidence-based teaching based on class size. Faculty participants were somewhat aware of evidence-based teaching but found it hard to implement given the limitations of class size and structure (Henderson & Dancy, 2011).

Participants in this department case were clear that their self-efficacy to facilitate active learning strategies was not an issue. They modified their teaching approach based on class size and class layout. If the class is large, then they defaulted to a transmissionist approach to teaching with occasional Q&A and clicker questions. However, when the class is small, these participants were more motivated to use evidence-based teaching. There was clearly a disconnect on the skills needed for facilitation in a small versus a large classroom. One could assume that the same skills needed for small classroom use of evidence based teaching could be used in large classrooms. It could be of value to address the class size and structure limitations by showing how some evidence-based teaching can be implemented in large lecture through videos or observations. This would also give faculty an opportunity to see other examples of how higher education faculty facilitate learning in classrooms.

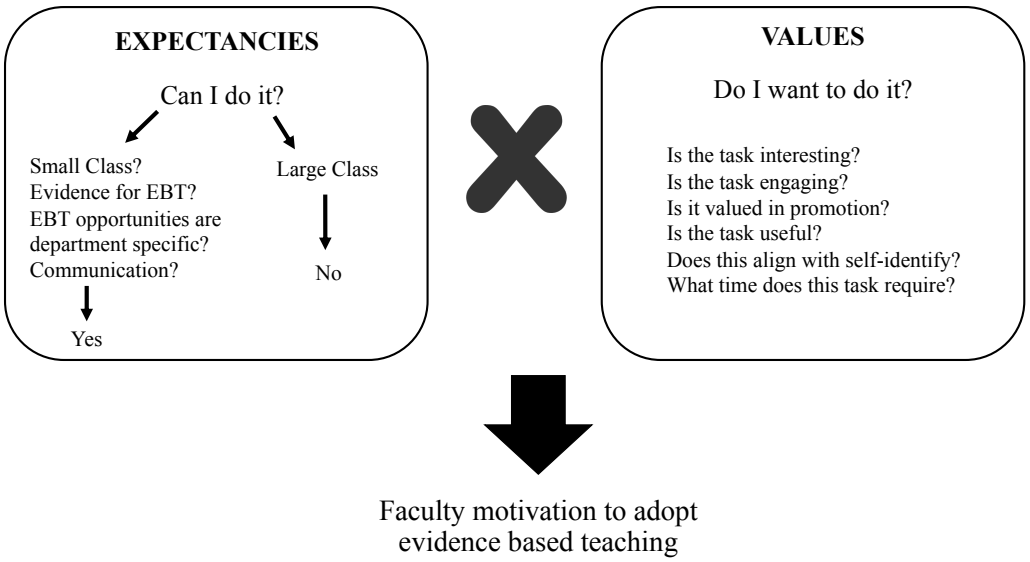


Figure 21. This is a modified model interpretation of the EVT theory for department Case 1 based on case analysis in this specific context.

Case 1 participants overall identified as researchers (SIR). Some participants self-identified as a teacher but stated this was mostly due to being at the end of their careers where research was less critical to their professional advancement. The EVT attainment value was used in a specific way in the model by asking how identity may inform how the task of teaching and attainment value align. The self-identity of the faculty may play a role in how they value the task of evidence-based teaching in the process of student learning (Zint, 2002; Brownell & Tanner, 2012).

Learning occurs in complex social environments, so this study is not proposing that student learning was not happening in Case 1 (Bransford et al., 2006; Rogoff, 1998). Instead, this study has observed that a climate of communication amongst faculty could foster a climate of discussion in the classroom between faculty and students and impact learning because learning can be a social activity (Bransford et al., 2006; Rogoff, 1998). Models focused on the research-to-practice cycle should consider communication between three stakeholders, students, peers, and the administration. This model is specific to Case 1 and takes into account class size, communication, identity, and the need for credible evidence as a localized approach for faculty change (Figure 20). The next section describes the major findings in Case 2 and how they built towards a specific EVT model for the Case 2 context.

Case 2 Major Findings

In Case 2, this department appeared to support faculty using evidence-based teaching, and this department could be used as a model for starting a movement towards evidence-based teaching in a similar context. The participants felt confident in identifying as both researcher and teacher. This department valued student voice in the classroom. In

Case 2, the instructor and students' voices were also valued, and the use of strategies that appreciated student voice was modified for large classes. In the Case 2 participant DART output, you could see many strategies emerging throughout the class and multiple strategies where student voice is the product of those strategies.

In Case 2, there was a supportive mentorship model for new faculty and faculty struggling with teaching. Case 2 valued communication with peers, students, and allowed pre-tenure faculty to sit in on all promotion meetings and decisions. In Case 2, teaching expectations were communicated, and faculty members in this department were motivated to achieve those expectations. In Case 2, large lecture classes were modified but with an attempt to still use the EBT strategies used in small classes.

A participant in Case 2 describes the need for annual course teaching relief to provide more time to focus on teaching or re-designing a class. Perceived lack of time is a crucial barrier to any work in higher education science professional development. Time was built into both proposed models for how to work with participants in the future in a similar context (Figure 20; Figure 21). The Case 2 environment had built a climate where valuing one's role as researcher and teacher were expected to achieve tenure. The need for teaching relief, more time for teaching, and recognition of the importance of teaching as important for adopting evidence-based teaching align with other studies (Kim et al., 2018; Henderson & Dancy, 2011).

In Case 2, there was a climate of communication with peers, student voice was valued, participants attended CTL workshops, and the administration put in writing what they expected of their faculty. The result was a focus on evidence-based teaching and

student learning and these ideas from this localized case were built into a modified EVT model.

Case 2 Modified EVT Model

A modified version of the EVT theory model was created for department Case 2 based mostly on the expectancies for success and task values expressed in the pursuit of adoption of EBT (Figure 21).

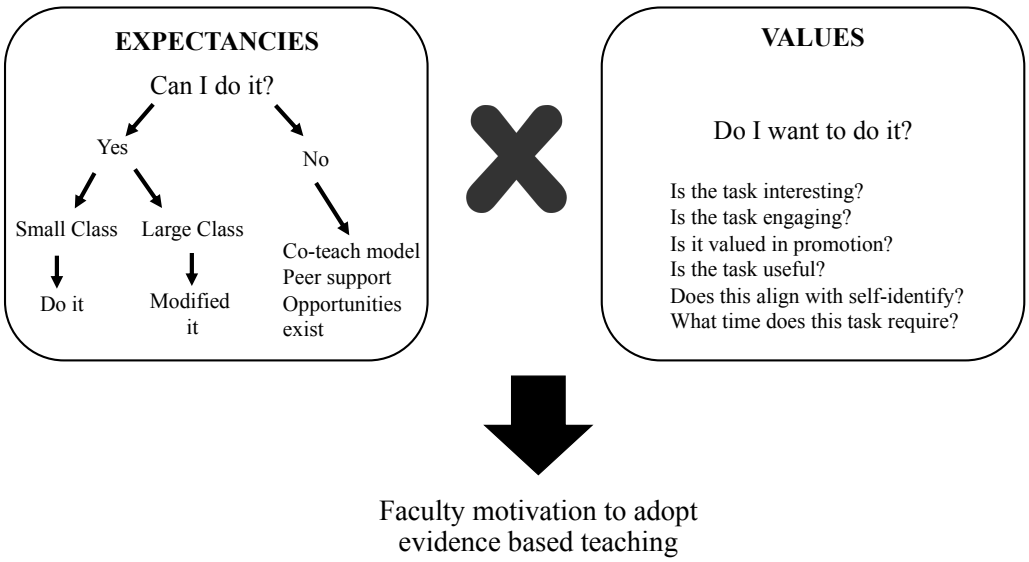


Figure 22. This is a modified model interpretation of the EVT theory for department Case 2 based on case analysis in this specific context.

Expectancies are the ability to succeed so this makes sense theoretically that if one cannot do a task, then there is no real consideration needed of the value you place on a task. In Case 2 the inhibiting expectancy of class size was modified for larger class sizes so that some participants still used evidence-based teaching strategies. Not all

participants in department Case 2 adjusted their small class EBT strategies for a larger class. It could be of value in a future study to understand why some Case 2 participants were motivated to use evidence-based teaching in a large lecture. The barrier of class size was mentioned but some Case 2 participants had found ways to overcome this barrier. It seemed to be rooted in the department culture to understand teaching barriers and work together to address them. For example, a seasoned member of Case 2 was mentoring new faculty to rope off a row in their large lectures. They were doing this so they could access students sitting in the interior of these large stadium seating classrooms. The Case 2 participants stated that it was their job to impact as many students as possible.

The department in Case 2 was also structured so that new faculty would co-teach their first year and see EBT strategies happening in large lecture classes. Further, struggling seasoned faculty were assigned another mentor to help support their teaching practice. Finelli et al (2014) found in their study with faculty a desire for a mentorship models like that of Case 2. Faculty in this study and the Finelli et al (2014) study stated they wanted individualized support from a mentor to implement evidence-based teaching. Hence, the design of this model suggests that even if participants in this climate do not feel they have the ability to succeed, those structural supports created through co-teaching and mentoring model could address expectancy concerns (Figure 21). Future PD plans using EVT as a framework could consider this model when thinking about mentorship as a PD component. The next section describes how classroom voice measurements could also have an impact on professional development plans.

The Potential Impact of Measuring Classroom Voice

Teacher voice, the teacher and student interactions, and the student interactions are classroom transactions that support meaning making negotiated through language (Chin, 2006). DART created a way to measure these transactions by percentage. The DART output provided a baseline of instructor voice and student voice in each case. The average amount of faculty talk in the class for department Case 1 was 93.5%, and for department Case 2 was 85.5%. It is important to unpack what it means to devote one minute to the voice of the instructor versus the voices of the students. Student voice in the classroom provides an opportunity for students to verbalize their understanding and it gives science faculty the chance to hear alternative conceptions and provide feedback.

If a class is 100 minutes, the effort to devote one minute to student voice through a peer share for a question is a calculation of 1% of the class now being dedicated to student voice. Faculty can use classroom voice as a measurement tool and monitor how much class time is devoted to student voice or shared learning. For example, if the instructor allows for 5 minutes of class time to have students work through a word problem, that can quickly, in the same scenario, translate to 5% student voice in a 100-minute class. Classroom voice data is an accessible resource for self-analysis for those interested in adopting evidence-based practices. This is important as many evidence-based practices are student-centered and can be measured by the quality use of student voice.

Study Implications

This study expanded on critical theory in science higher education, the Expectancy-Value Theory, by creating context-specific models to support the adoption of evidence-based teaching. Additional codes specific to exploring motivation and evidence-based teaching should be considered in future work because of their practical application to structures such as promotion policy. The exploration of self-identity as a researcher and teacher were also some of these additional codes and essential to the use of EVT values. This study added to the body of work that has shown if student learning is vital then addressing class size and layout is needed to support faculty motivation to adopt evidence-based teaching. Faculty members make key teaching decisions based on the enrollment size and the shape of a room. If student learning is essential, then designing classrooms for student learning should be considered.

Faculty members wanted to honor their place in the curriculum, and this can drive content coverage decisions like choosing broad content coverage versus deep content coverage. This concept is important when considering student learning, content coverage responsibilities, and what departments realistically expect students to learn long term. Content coverage is a teacher-centered approach to learning and a focus on communicating student-centered expectations focused on the quality of learning content could be impactful.

A student-centered shift could be supported by creating expectations of a student-centered classroom in student evaluations. Faculty pay attention to the language in student evaluations and tailor their classes to these assessments. The same goes for tenure policies, and this study suggests a regular audit of policies for two things. One suggestion

is to audit policies to see if they are opinion or evidence-based. Another suggestion is to align policies with evidence-based research but also evidence-based teaching. The communication of policies is important but so is the promotion history as faculty pay attention to who gets promoted and the perception of why a promotion occurs. Departments can improve teaching expectations by aligning promotion history with what they want to communicate to faculty about expectations.

A significant impact of this study will be on the future design of professional development. Teaching expectations should align with professional development but also with what is getting measured in a department or university. What gets measured gets noticed, and this was apparent in the teaching expectations throughout student evaluations, tenure policies, awards, and classroom voice data. These measurement tools should be evaluated and used in the teaching side of faculty promotions. Future professional development could survey the climate of departments before designing PD. Faculty asked that the PD be department specific and built on communicated credible evidence for the impact of science education research. There were many requests to host PD during faculty meetings or at times that work better with their schedule. Faculty members were open to science education experts working directly in a one-on-one setting and want access and a way to approach these experts.

There is a real opportunity to listen and reflect on what faculty members are directly telling us in this study. There is an opportunity to break down the abilities to succeed and the values of the task of teaching to have a long-lasting impact on faculty motivation. The researcher took the data and these insights from this study and created a professional development model, the Teach by Example Professional Development

model (TBED). The phrase "teach by example" is built off the idea of leading by example (Figure 22). The three tenets are building new learning from prior experiences, creating a supportive learning climate, and using both of these to design development based on local motivational components.

What the participants said about class size aligns with the findings in Finelli et al. (2014), that classroom structures can influence the adoption of evidence-based teaching. Faculty indicated they could succeed (expectancy) using active learning strategies, but they felt required moveable chairs and tables for group work. Motivation is supported by what faculty think will happen, will they succeed or fail, if they try a task and the value they place on this task (Eccles et al., 1983; Wigfield & Eccles, 2000; Finelli et al., 2014). If students need to be engaged to learn then how conducive a room is for learning would impact the experience and activity of learning (Fredricks, Blumenfeld, & Paris, 2004).

Learning is complex and influenced by not only the individuals (students) but the space that learning is assigned. These ideas are not new, existing in the literature for science educators to probe, but they may be new for faculty who have spent years examining their own disciplines' body of work. Hence, it is important to consider the faculty's prior experience with science education research.

Teach By Example Professional Development Model (TBED)

The TBED was built on the idea that to support motivation, professional development should consider previous experiences of faculty and students. Development is defined as interpersonal growth and learning that can come from the classroom for students and the workshop classroom or PD program for faculty. Expectancy is the ability to succeed, "Can I do it?" and value is the value placed on a task, "Do I want to do it?".

Figure 23. The Teach by Example Professional Development model designed for PD facilitators in designing PD for the adoption of Evidence-Based Teaching by leading by example using the same expectations for faculty and student classroom learning.

The researcher's goal was to design professional development (PD) opportunities that model evidence-based teaching with faculty that they, in turn, could use in class with students. If TBED is implemented successfully, the faculty potentially could emerge from a PD plan using evidence-based teaching that modeled how to use motivation through the lens of EVT for their teaching practice but also with student motivation. However, this model needs to be piloted and tested to understand if it has the impact intended. Below the components of this potential model are described.

Prior Experiences:

Understanding the prior experiences of students helps with course design, understanding alternative conceptions, and building new knowledge. The same can be said for understanding prior experiences of faculty to make PD plans. The model suggests using formal and non-formal pre-assessments of students' experiences and knowledge and using pre-survey or pilot work to build upon the faculty's prior experiences to design PD plans.

Supportive Learning Climate:

It takes many things to create a supportive learning climate. The model cites a few such aspects such as resources and policies for faculty and relationship building and clear expectations for learning in the syllabus.

Development Based on Local Motivation:

This tenet brings together the prior experiences, the needs for a supportive learning climate, expectancies and values placed on learning and teaching. The goal is to use all of the preliminary assessment work to create this final tenet based on the Expectancy-Value Theory.

Expectancies for Learning and Teaching:

The model suggests that through the pre-assessment work with both faculty and students a PD expert could find the abilities to succeed or fail (expectancies) that could be important for successful development implementation.

Values for Learning and Teaching:

The Expectancy-Value Theory suggests that the value one places on a task can determine the motivation to do a task. In the classroom for students and faculty, it is vital

to design tasks that they can see the value of as related to the course, workshop, or PD plan. One key component of implementing a PD plan like the TBEPD is using evidence and measuring classroom voice in the PD workshops and the classes of participants.

Conclusion

Students should have opportunities to learn content from content specialists. Students today have access to inaccurate and accurate content through the internet any time they want (Silverthorn, 2006). However, one of the roles of science education is to train new scientists who will hopefully go on to extend new scientific knowledge. It is essential for student learning to allow these future scientists the same opportunities to verbalize science in a science classroom because that is what scientists do (Chi, de Leeuw, Chiu, & LaVancher, 1994; Coleman, Brown, & Rivkin, 1997; Smith et al., 2009; van Blankenstein, Dolmans, van der Vleuten, & Schmidt, 2011; Webb, 1989). Scientists discuss and debate science in research groups, through the literature, and at conferences. This means that student learning and the correlation to teaching methods should be considered in these modified motivation models.

The goal of this study was to provide insight into why faculty members are not using education research to inform their teaching practice. Learning is an active process yet often in larger classes the activity exists mainly with instructor voice (Dewey, 1938; Piaget, 1964; Vygotsky, 1986; Mazur, 2009; Eagan, 2016). The impact of this study adds to the collection of studies focused on the research-to-practice gap and has the potential for a deeper understanding of faculty motivation and by extension student learning.

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APPENDICES

APPENDIX A

Institutional Review Board Approval

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

MIDDLE TENNESSEE STATE UNIVERSITY

IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE

Friday, November 09, 2018

Principal Investigator	**Penny Carroll** (Student)
Faculty Advisor	Grant Gardner
Co-Investigators	Josh Reid
Investigator Email(s)	*penny.carroll@mtsu.edu; grant.gardner@mtsu.edu; jwr4k@mtmail.mtsu.edu*
Department	Mathematics & Science Education and Biology
Protocol Title	***A science faculty motivation analysis to understand how to increase student voice***
Protocol ID	**19-2077**

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the category *(7) Research on individual or group characteristics or behavior.* A summary of the IRB action and other particulars in regard to this protocol application is tabulated below:

IRB Action	**APPROVED for ONE YEAR**		
Date of Expiration	**11/30/2019**	Date of Approval	11/9/18
Sample Size	100 (ONE HUNDRED)		
Participant Pool	Primary Classification: **Healthy Adults (18 or older)** Specific Classification: **Tenure/tenured faculty from universities**		
Exceptions	1. Collection of participant contact information for scheduling is permitted. 2. Voice recording and video are allowed (with restriction) 2. Online survey and online informed consent are permitted		
Restrictions	**1. Mandatory active informed consent; the participants must have access to an official copy of the informed consent document signed by the PI.** **2. Identifiable personal information must not be used beyond data processin.** **3. Raw video/audio data must be destroyed after the data have been transcribed/analyzed.**		
Comments	NONE		

This protocol can be continued for up to THREE years (**11/30/2021**) by obtaining a continuation approval prior to **11/30/2019**. Refer to the following schedule to plan your annual project reports

and be aware that you may not receive a separate reminder to complete your continuing reviews. Failure in obtaining an approval for continuation will automatically result in cancellation of this protocol. Moreover, the completion of this study MUST be notified to the Office of Compliance by filing a final report in order to close-out the protocol.

Post-approval Actions

The investigator(s) indicated in this notification should read and abide by all of the post-approval conditions imposed with this approval. Refer to the post-approval guidelines posted in the MTSU IRB's website. Any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918 within 48 hours of the incident. Amendments to this protocol must be approved by the IRB. Inclusion of new researchers must also be approved by the Office of Compliance before they begin to work on the project.

Continuing Review (**Follow the Schedule Below:**)

Submit an annual report to request continuing review by the deadline indicated below and please be aware that **REMINDERS WILL NOT BE SENT.**

Reporting Period	Requisition Deadline	IRB Comments
First year report	10/31/2019	NOT COMPLETED
Second year report	10/31/2020	NOT COMPLETED
Final report	10/31/2021	NOT COMPLETED

Post-approval Protocol Amendments:

Only two procedural amendment requests will be entertained per year. *In addition, the researchers can request amendments during continuing review. This amendment restriction does not apply to minor changes such as language usage and addition/removal of research personnel. .*

Date	Amendment(s)	IRB Comments
NONE	NONE.	NONE

Other Post-approval Actions:

Date	IRB Action(s)	IRB Comments
NONE	NONE.	NONE

Mandatory Data Storage Requirement: All of the research-related records, which include signed consent forms, investigator information and other documents related to the study, must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data storage must be maintained for at least three (3) years after study has been closed. Subsequent to closing the protocol, the researcher may destroy the data in a manner that maintains confidentiality and anonymity.

IRB reserves the right to modify, change or cancel the terms of this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:

Click here for a detailed list of the post-approval responsibilities.
More information on expedited procedures can be found here.

APPENDIX B

Faculty Motivation Survey

Basic information

1) How long have you taught undergraduate biology as an instructor of record?
   Less than a year 1 to 5 years 6 to 10 years 10-15 years 15 years or more

2) Have you had any formal training in instruction or pedagogy (a degree in Education or related field, coursework specific to education, etc.)? Y/N

3) How many professional development opportunities related to teaching do you typically attend per year (on average)

A) 0
B) 1
C) 2
D) 3
E) 4
F) 5 or more

4) How much talking do you do in the classroom and how much do your students do, on average? Pick the choice closest to what, on average, describes who is talking in your classroom.

A) Instructor 100% Students 0%
B) Instructor 98% Students 2%
C) Instructor 75% Students 25%
D) Instructor 50% Students 50%
E) Instructor 25% Students 75%
F) Instructor 2% Students 98%
G) Instructor 0% Students 100%

5) If one were to observe your typical classroom, what would they see? Open ended

Below are from SCII & STEBI and have a Likert scale of strongly disagree through strongly agree.

Resources

Instructors in my department have adequate departmental funding to support teaching.

Instructors in my department have adequate space to meet with students outside of class.

Instructors in my department have adequate time to reflect upon and make changes to their instruction.

Professional Development (PD)

Instructors in my department are assigned a mentor for advice about teaching.

In my department, teaching development events (i.e. talks, workshops) are hosted specifically for Department instructors.

In my department, new instructors are provided with teaching development opportunities and resources.

Autonomy

Instructors in my department have considerable flexibility in the content they teach in their courses

Instructors in my department have considerable flexibility in the way they teach their courses.

In my department, there are structured groups organized around the support and pursuit of teaching improvement.

Respect

Evidence of effective teaching is valued when making decisions about continued employment and/or promotion.

Differences of opinion are valued in decision-making related to teaching improvement.

Courses are fairly distributed among instructors.

Teaching is respected as an important aspect of academic work.

All of the instructors in my department are sufficiently competent to teach effectively.

Collegiality

Instructors in my department frequently talk with one another.

Instructors in my department discuss the challenges they face in the classroom with colleagues.

Instructors in my department share resources (ideas, materials, sources, technology, etc) about how to improve teaching with colleagues.

Instructors in my department use teaching observations to improve their teaching.

Instructors in my department are "ahead of the curve" when it comes to implementing innovative teaching strategies.

Instructors in my department have someone they can go to for advice about teaching.

Self-efficacy (STEBI)

In my classroom…

- I am continually finding better ways to teach science.
- if students are underachieving in science, it is most likely due to ineffective science teaching.
- increased effort in science teaching produces little change in students' science achievement.
- I usually welcome student questions.

- I have sufficient abilities to facilitate classroom discussions.
- I have sufficient abilities to balance the required content coverage and engaging in deep student learning.

Please use this space to describe for this study anything else you think is important to know about your teaching and faculty motivation. _____

APPENDIX C

Interview Protocol for Faculty Motivation Research

1. What motivated you to start a career in which teaching is a significant job requirement?
2. If there were a spectrum from researcher to teacher, where would you place yourself? Where would you say you identify?

   Researcher _____Teacher
3. Do you talk to your peers about your teaching practice or strategies in the classroom? Why or why not?
4. What (if any) are the barriers impeding you from teaching how you want?
5. If all the barriers such as time were removed, how would you teach? Would it be different? Would you incorporate any additional strategies to the strategy of lecturing? If not, what would it take?
6. Is it important that students be talking about biology in your classrooms and why or why not?
7. How difficult do you think it would be for you to increase student talk about biology in your classroom?
8. What does effective science teaching look like?
9. What role does covering content play in your teaching decisions? What is your opinion about the amount of content covered?
10. In your opinion, what do you think it would take to get other faculty to try strategies in lecture where students are talking more in class?

11. What do you think it would take to get other faculty to adopt active learning or evidence-based teaching in the classroom?
12. What do your tenure guidelines say about teaching? What do you think about the tenure teaching expectations? Do the guidelines accurately reflect real expectations?

APPENDIX D

Faculty Motivation Codes - The goal is to find motivators that are **inhibiting** and **supporting** engagement in the evidence-based teaching.

E – Expectancy to succeed at a task.

- **SE+ or SE**- Self-efficacy – I am/I am not self-confident in my ability to teach or use EBT

  -Should be coded as **SE+** (if one is confident in their ability to do a task) or **SE-** (if not)
- **CK+ or CK**- Content knowledge – I know/I do not know the content to be successful at teaching and EBT
- **HK+ or HK-** I have/I have not the ability to use technology, activities, and strategies for teaching or evidence-based teaching. How to knowledge.
- **IR** - Interpersonal relationships – ability and opportunities to work with others specifically department peers (Relatedness SDT)
- **Size** - Class size –Code for this when class size is mentioned as an issue/benefit/barrier.
- **Layout** - code this when the layout of the classroom is an issue/benefit/barrier
- **OP** – opportunity and access to teaching resources, experts, professional development etc

  -OP+ - there are opportunities & I value them **OP-** there are not opportunities or I don't value them
- **Evid** –evidence on the positive influence of effective teaching, EBT comes up. **Evid+** if they mention they are aware of evidence or **Evid-** if they suggest there are issues with the credibility of evidence for EBT

Value (**V**) - the value one places on a task is deeply embedded in one's behavior to move towards a goal. Code V for value if there is a general value emerging that is not indicated in the Value subcodes below.

- **IN** - Interest or intrinsic value - activity enjoyment or lack of interest?? IN+ for interest or IN- for no interest in teaching related activities. This is different from use because interest is more of do they enjoy something versus do they see something as useful. You can enjoy something that is not useful and find something useful that you may not enjoy.
- **Use** - Utility value - activity usefulness. Code any statements Use+ if an activity is of value or Use- if an activity is not of use. This can be used in how they value any activity involved with teaching, professional development or interactions around these (i.e. do they find talking to peers of use).
- **Cost** - the activity expense of engaging or not.
- **AT** – achieving tenure is valued and teaching is seen as less of a value because they state that research, publications, grants are of more value. Teaching may be a cost to the time needed for AT.
- **AU** – Autonomy is of value (self-determination theory)

- **Control** - the cost of control is the cost of control over the classroom itself; perhaps the cost of classroom management that is required to use evidence based practices.
- **Content** - Cost of content - is the value of how much content is expected to be covered and the motivation to use evidence based practices to cover content.
- **Time** – if time is a barrier or cost to teaching, PD, or anything related to the use of EBT.
- **EV** – values engagement or interaction
- **IVV** - Instructor Voice Value (IVV) – values instructor voice in the classroom
- **SVV** - Student Voice Value (SVV) – values student voice in the classroom
- Attainment value - the degree to which an activity is consistent with sense of self.
- **SIT** – self-identifies as a teacher mostly (attainment value)
- **SIR** – self-identifies as a researcher mostly (attainment value)
- **SIB** – self-identifies as both but is very clear with a statement like "I do both I am 50/50". (attainment value)