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EXAMINING THE GOAL SYSTEMS OF STUDENT TEACHERS

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EXAMINING THE GOAL SYSTEMS OF STUDENT TEACHERS

by

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Examining the Goal Systems of Student Teachers

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Understanding why novice science teachers use certain practices and not others upon entering the classroom remains an important question for those conducting research on science teaching and learning. Previous research suggests two important avenues for further study of science teachers: (1) more careful study of the student teaching semester; and (2) additional studies on the cognition of teachers. This study follows these traditions via investigation into the cognition of student teachers. The theoretical framework guiding this study draws upon goal-driven theories of cognition suggesting that teachers hold multiple goals that exist in goal systems. A teacher's classroom practice is directed toward the satisfaction of one or more of these goals. Furthermore, goals can be reinforcing—the pursuit of one goal simultaneously satisfies a second goal—or goals can be conflicting—the pursuit of one goal inherently prevents the satisfaction of a second goal. Thus, a more careful study of the goal systems of teachers can lead to a deeper understanding of why science teachers use the practices they do in their classrooms. Given the theoretical framework, the research question driving this study is: *what is the content of the goal systems of student teachers of science as they reflect on and plan for their first year of teaching?* Qualitative methods, including interviews and document analysis, were used to investigate the goal systems of four student teachers at a large, southern state university during the spring of 2014. Findings from this study suggest novice teachers exit teacher education having integrated into their goal systems many, but not all, of the pedagogical approaches emphasized in their teacher education program. Findings also suggest that at the same time, student teachers have goals reflective of broader aspects of the school organization—goals such as teaching the state standards and collaborating with other science teachers. Finally, this study suggests that the goals student teachers hold with respect to the school organization may conflict with their pedagogical goals developed during teacher education, leading to movement away from the reform-oriented practices emphasized in teacher education. Finally, implications for teacher education and directions for future research are presented.

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Chapter 1: Introduction

Recognizing the central role teacher's play in the education of students, researchers in science education have, for some time, sought to more fully understand why teachers teach in the manner that they do (Crocker & Banfield, 1986; Kennedy, 2005; Tobin & McRobbie, 1999). Researchers in science education have further inquired as to why, despite years of reform oriented teacher education, promoting constructivist, inquiry oriented approaches to science teaching and learning, do so many teachers use traditional, didactic methods in their science classrooms (Abell, 2008; Crawford, 2007; Fletcher & Luft, 2011; Kennedy, 2005). As Kennedy (2005) asks, "how can it be that people who are well educated and committed to their work engage in practices that receive so much criticism" (p. 2)?

There is an emerging notion that part of the answer to Kennedy's question in the preceding paragraph may come from more careful study of the student teaching semester. Ronfeldt, Reininger, and Kwok (2013) suggest classroom practice during the student teaching semester is strongly predictive of a teacher's pedagogy and practice upon entering the classroom as a full time teacher. Thus, purposefully designed student teaching experiences can serve as a launching pad for enactment of reform-oriented instructional approaches (McIntyre, Byrd, & Foxx, 1996; Ronfeldt, Reininger, & Kwok, 2013). At the same time, student teaching can be equally miseducative, and often leads student teachers to adopt traditional models of teaching and interacting with students (McIntyre, et al., 1996; Rozelle & Wilson, 2012).

Due to the strong connection between classroom practice during the student teaching semester and subsequent teaching practice during induction years, the student teaching semester is viewed as the most important aspect of teacher education (Anderson & Stillman, 2013; McIntyre, et al., 1996; National Council on Teacher Quality, 2011; Ronfeldt & Reininger, 2012; Rozelle & Wilson, 2012). For those interested in answering Kennedy's (2005) question, gaining further insight into the pedagogical development of student teachers may be of particular importance.

THE TWO WORLDS OF STUDENT TEACHING

The student teaching semester is "typically the first time prospective teachers assume lead teaching responsibilities for an extended period of time" (Ronfeldt, et al., 2013, p. 319). Furthermore, as Coble and Koballa (1996) noted, "it is during student teaching that preservice teachers are most able to operationalize what they have learned in science and science methods courses and receive feedback on matters of science teaching and learning" (p. 474). Thus, the student teaching semester occupies a unique place in the development of a teacher: for the first time, they assume the full role of a teacher, while for potentially the last time, they are in the role of student. This tension has been referred to as the "two worlds" of student teaching (McDiarmid & Clevenger-Bright, 2008)

The pull of the two worlds can become problematic for student teachers, as often there exists differences in the definition of good teaching between university facilitators and school based cooperating teachers (Valencia, Martin, Place, & Grossman, 2009; Weiland, 2008). Furthermore, the objectives for the student teaching semester differ between the two worlds as well. Teacher educators often view the student teaching semester as the final part of formal teacher education. Thus, from the point of view of the teacher educator, student teaching is a learning experience that allows preservice teachers to develop their craft, to experiment with different styles and strategies, and to see what works for them as they begin to solidify their pedagogical approach (Abd-El-Khalick & BouJaoude, 1999; Anderson & Stillman, 2013; Jones & Veslind, 1996; Valencia, et al., 2009).

In contrast, cooperating teachers may not be as willing to allow for student teachers to experiment within their classes. The objective for student teachers, from the point of view of many cooperating teachers is for the student teacher to effectively teach the students in their class. For those student teaching in the spring semester, this also includes the possibility of ensuring students pass a state-level high stakes assessment. Brown (2010) and Anderson and Stillman (2013) both find that the shadow of accountability policies influence the student teaching experience, as cooperating teachers remain accountable to their school for students in their classes passing high stakes tests. This can result in the miseducation mentioned earlier if the cooperating teacher does not feel the methods promoted in teacher education are effective approaches to teaching his or her students and preparing them for the state level exam. Often, this leads to increased tension between the triad of university-based faculty mentors, cooperating teachers, and student teachers (McDiarmid & Clevenger-Bright, 2008; McIntyre, et al., 1996; Valencia, et al., 2009).

Student teachers are often pulled in two directions by two powerful actors. On the one hand, they are pulled in the direction of research-based practice by their university faculty who oversee the student teaching semester. On the other hand, they can be pulled in the direction of more traditional pedagogical approaches by their cooperating teacher, a pull often exacerbated by high stakes accountability tests. Thus, many researchers are interested in how the student teaching semester both works against and contributes to the "practices that receive so much criticism" (Kennedy, 2005, p. 2).

TEACHER COGNITION

Beginning in the late 1970s, education researchers began to draw on cognitive theories of psychology in their attempts to answer the aforementioned, long-standing question restated by Kennedy (2005). This shift toward cognitive theories included the study of science teachers at all points of their careers, including teacher education, student teaching, and entrance into the classroom (Grossman, 1990; McDonald, Kazemi, & Kavangh, 2013; Richardson, 2003; Russ & Luna, 2013). The shift from behaviorist approaches to cognitive approaches was grounded in the notion that "what teachers do is affected by what they think" (Clark & Yinger, 1987, p. 231). As a result, teacher educators and educational researchers often appeal to teacher thought processes as the determinants of why teachers use certain practices and not others in their classrooms (Hiebert & Morris, 2012; Kennedy, 2010).

Initially, research on science teachers drawing on cognitive theories of teacher decision making focused on the "beliefs and knowledge of individuals as the primary motivators behind teacher's actions" (Webel & Platt, 2015). Those interested in beliefs research found the beliefs of science teachers with regards to science, inquiry, students, and schooling played a significant role in the pedagogical choices of science teachers (Crawford, 2007; Jones & Leagon, 2014; Roehrig, Kruse & Kern, 2007). At the same time, those interested in the knowledge side of the equation began to recognize the importance of the various knowledge bases outlined by Shulman (1987) as determinants of teaching practice (Gess-Newsome, 1999b; Magnusson, Krajcik, & Borko, 1999). Within research on science teachers, the two knowledge bases to receive the most attention have been content knowledge and pedagogical content knowledge (PCK). Findings from this line of research converge to suggest strong content knowledge and robust PCK are more likely to lead to inquiry-oriented pedagogical approaches on behalf of science teachers (Van Driel, Berry, & Meirink, 2014).

However, research shows reform oriented beliefs, strong content knowledge, and robust PCK do not predict classroom practice to the degree one might expect. In a review of the literature on novice science teachers, Davis, Petish and Smithey (2006) note that there is a preponderance of evidence for “a mismatch between teachers’ ideas and practices—their ideas about instruction seem generally to be more sophisticated and innovative than are their actual practices” (p. 621). In other words, having a set of beliefs, content knowledge, and PCK aligned with reform-based practice does not in and of itself translate into pedagogically sound teaching practice.

There is a growing recognition that a teacher’s beliefs and knowledge may not be the sole determinants of their classroom practice. Some have begun to criticize the reliance on teachers’ beliefs and knowledge as flawed, citing a prevalence of the fundamental attribution error in research on teachers (Hiebert & Morris; 2012; Kennedy, 2005; 2010; Ross & Nisbett, 1991). The fundamental attribution error, as defined by Ross and Nisbett, 1991), is an "inflated belief in the importance of personality traits and dispositions, together with [a] failure to recognize the importance of situational factors in affecting behavior" (p. 4). Kennedy (2005; 2010) applies the work of Ross and Nisbett (1991) to research on teachers, suggesting researchers often overemphasize the importance of personal cognitive constructs, such as knowledge and beliefs, and underestimate the influence of situational factors when studying teachers' classroom practice. In order to more fully account for why teachers do what they do, we must recognize that schools are information rich contexts influencing teacher cognition and the resulting classroom practice in important ways.

Those who favor appealing to and researching the contextual influence on teaching recognize "the activity and practices of teaching always take place in a setting that is already interpreted and understood; a setting, in fact, that has typically been designed and produced to support and sustain a particular mode of teaching-and-learning" (Packer & Winne, 1995, p. 2). In other words, the school environment has been designed to produce particular practice by teachers, regardless of their beliefs and knowledge. Researchers who subscribe to contextual models further suggest that setting can include both the physical structure of the school (i.e. the design of a classroom, or a science teacher teaching in a portable classroom) as well as the social structure (i.e. a strong department culture, or the presence of accountability policy (Cuban, 2009; Datnow, 2006; Ingersoll, 2003).

At the same time, there have been findings suggesting that taking account of setting may not be as fruitful as we might hope. As an example, Blanchard, Southerland and Granger (2009), found that despite the absence of many of the contextual barriers that teachers often cite as preventing inquiry-based practice, teachers in their study did not adopt inquiry based approaches to the extent that teachers in less supportive contexts did. They also found that the presence of contextual factors supportive of inquiry-based teaching (i.e. curricular materials or mentoring support), teachers remained committed to the use of more traditional methods in their science classrooms. The school setting did not shape the practice of these teachers in the way that Packer and Winne (1995) might suggest.

Despite the collective effort of many researchers, the field continues to lack in explicating the relationship between the cognition of teachers and the pedagogical choices leading to classroom action. Recognizing that the two approaches mentioned above have both inherent strengths and potential weaknesses, others have proposed the use of hybrid models, whereby there is an interplay between beliefs, knowledge, and environments. For example, in an effort to understand why so many educational reform efforts are unsuccessful, Woodbury & Gess-Newsome (2002) propose the:

> Teacher-Centered Systemic Reform (TCSR) model that highlights teacher thinking as a central factor shaped by the interdependent influences of (a) the general context of reform, (b) a teacher's personal profile, and (c) the structural and cultural contexts of teachers' work within embedded systems (p. 764).

In the TCSR model, while contextual factors can, and do, shape both teacher thinking and teacher practice, the central factor influencing a teachers practice is their beliefs and knowledge (Woodbury & Gess-Newsome, 2002).

The study reported here is guided by the notion that a more robust model of teacher cognition is necessary to fully understand the cognition of science teachers. However, it differs from models such as the TCSR in two important ways. First, the model driving this study suggests that a teacher's goals are distinct cognitive structures separate from knowledge and beliefs—an approach that will be detailed further in Chapter 2. This is in contrast to the tendency to treat goals as a subset of beliefs and/or knowledge (Belo, Van Driel, van Veen, & Verloop, 2014; Wallace & Kang, 2004; Webel & Platt, 2015) As example of this tendency, Friedrichsen, Van Driel and Abell (2011) "propose defining science teaching orientations as a set of beliefs with the following dimensions: goals and purposes of science teaching…" (p. 358). In other words, Friedrichsen and colleagues subsume goals as part of the belief sets of teachers.

The second way this study differs from approaches such as the TCSR model is the assumption that it is the equal interplay of goals, knowledge, beliefs, and contexts in a teacher's cognition that leads to classroom practice. Thus stands in contrast to research that often prioritizes either beliefs, knowledge, or context at the expense of other influences on context. This tendency includes approaches such as Woodbury and Gess-Newsome (2002) who, while allowing for contextual factors, suggest the primary driver of cognition is teacher beliefs. It also stands in contrast to approaches taken in a similar vein to Packer and Winne (1995) who suggest the primary influence on teacher cognition and action is context, while also recognizing a teacher's knowledge and beliefs do play a role in cognition.

GOALS: THE MISSING PIECE OF TEACHER COGNITION

The model of cognition guiding this study suggests that cognitive processes act over mental representations (i.e. mental information structures) to produce thoughts and actions (Anderson, 1983a; b; 1991; Palmer, 1978). Furthermore, cognitive processes act over three categories of representations: mediating states, environmental states[1], and goal states (Markman & Dietrich, 2000a; b; Dietrich & Markman, 2003). Mediating states are representations of elements such as, but not limited to, beliefs, knowledge, pedagogy, identities, ideologies, and biases. Environmental states corresponds to the current status of a person's environment context. Finally, goal states correspond to the future status of the environment. Goal states can correspond either to behavior a person will engage in at a future point in time (i.e. lecture students about the parts of the cell) or the result of such future actions (i.e. students learn the function of each part of a cell).

Current models of human cognition treat goal satisfaction as fundamental to understanding cognition and the resulting behavior of individuals (Aarts & Elliott, 2012; Carver & Scheier, 1998; Gollwitzer & Moskowitz, 1996). As Markman, Zhang and Moreau (2000) point out, "the choice situation is fundamentally connected to the satisfaction of some set of goals. Models of choice must provide information about how

[1] In their original formulation, Markman and Dietrich called these states information states. In a subsequent piece, Hunter and Markman (Under Revision) chose to rename them environmental states, in order to distinguish between information carried by other states and the specific information supplied by environmental factors. For this project, I use environmental states as well.

the goals relevant to a choice are determined and how they influence preference" (p. 346). In other words, one cannot account for the choices that a teacher makes leading to classroom practice without accounting for the goals that the teacher is pursuing and how such goals influence the desirability of particular pedagogical approaches (i.e. lecturing versus open ended inquiry versus argument-driven inquiry). More simply, those who use cognitive approaches to the study of teachers need to include goal representations in their models.

Current research on goal driven cognition and behavior suggests that individuals hold multiple goals at any given time (Fishbach, Dhar & Zhang, 2006; Moskowitz, 2012; Shah & Kruglanski, 2007; Stroebe, Konningsbruggen, Papies & Aarts, 2013). Moreover, these goals are not isolated from each other, but instead are related to each other via hierarchical goal systems, with more specific goals at lower levels of the hierarchy and more abstract goals at the higher levels (Boekaerts, de Koning, & Vedder, 2006; Carver & Scheier, 1998; Gollwitzer & Moskowitz, 1996; Locke & Latham, 1990; Markman & Brendl, 2005; Moskowitz, 2012; Shah & Kruglanski, 2007).Taken together, teachers hold multiple hierarchical goal systems that can influence their practice in important ways.

This approach is congruent with both emerging and established research on science teachers. With respect to the interrelated nature of goals, similar approaches have been used to understand teacher beliefs and knowledge, with the assumption that these cognitive elements do not exist in isolation, but instead are contained within belief and knowledge systems, respectively (Belo, et al., 2014; Jones & Leagon, 2014; Verjovsky & Waldegg, 2005). With regards to multiple goals, Kennedy (2005; 2006a; 2006b; 2008) has found teachers hold multiple intentions, or goals, for their classes and students, ranging from student learning to classroom management to their own personal psychological and emotional needs.

Purpose of the Study

As will be detailed in chapter 2, much is known about the role mediating states—elements such as beliefs, content knowledge and PCK—play in teachers' practice. There is also a substantial research base regarding the role that the physical and social environment plays in shaping teachers' practice. Considerably less, however, is known about the goal systems of teachers.

This study seeks to initiate a program of research that examines the goal systems of science teachers. Specifically, this study seeks to more fully understand *the content of the goal systems of student teachers of science as they reflect on and plan for their first year of teaching*?

Significance of the Study

This study is unique to research on science teachers in two ways. First, as mentioned above, the goal systems of teachers have been considerably under-researched as part of the effort to more fully understand the link between teacher cognition and classroom practice. Furthermore, as will be expanded upon in Chapter 2, for those studies that do look at goals, rarely do they distinguish goal representations from mediating states, particularly beliefs. In doing so, these studies make the assumption, at time implicitly, that having a belief in inquiry, for example, translates to having a goal to teach using inquiry, and vice versa. This study takes a different approach. It is possible, for example, to know about teaching via inquiry and have a belief that inquiry is beneficial to students without having the goal to teach through inquiry.

The second aspect setting this study apart from previous work is that research on teachers often asks teachers to reflect upon past events and their rationale for acting in the past, or to understand change in time of teachers understanding of their current situation. This investigation, on the other hand, looks to understand changes in preservice teacher thinking over the course the student teaching semester relative to a fixed point in the future: their first teaching job upon graduation. Thus, the study seeks to examine the development of the goal systems related to the first year of teaching for student teachers of science.

The significance of this study emerges when viewing the two aforementioned aspects in concert. Kennedy (2006a) remarks that teachers plan as if they are scripting a play, as opposed to the more linear lesson planning process promoted in teacher education. On this view, teachers are consistently thinking forward, mentally simulating routes toward the achievement of the goals they hold. The two main components of these mental simulations are that they occur relative to the goals of the teacher and they are simulations of future events. Thus, this study's significance lies in looking at the goal systems of student teachers as they think towards their future teaching practices, specifically the first year of teaching.

ORGANIZATION OF THE STUDY

The remaining chapters are organized as follows: in Chapter 2, I review the literature relevant to this study. First, I discuss in greater detail the theory of cognitive representation mentioned above. I then use that theory to frame a review of the literature related to teacher cognition and teacher practice. Specifically, I review the literature on the mediating states, environmental states, and goal states of teachers.

In Chapter 3, I discuss the methodology and methods that guide this study. First, I provide the theoretical framework of goal systems that frames the research question and the findings. Second, I detail the methodological assumptions underpinning cognitive qualitative research. Third, I provide the specific research questions that drive this inquiry. Fourth, I introduce the four participants that I worked with during the course of this study, contextualizing their student teaching semester. Fifth, I lay out the procedure for collecting data from the four student teachers. Sixth, I detail the data analysis approach that allows me to provide an answer to the research question. Finally, in Chapter 3, I discuss my own background as the researcher as instrument.

In Chapter 4, I provide the findings to the research question in respect to three domains. The first domain reflects the goal systems of student teachers with respect to their teacher education program. The second domain details the goal systems of the student teachers governing their response to systemic reform policy. The final domain in Chapter 4 describes the goal systems of student teachers as they relate to other people with whom they work in the school.

In the final chapter, Chapter 5, I discuss these findings in relationship to the more broad research agenda of understanding why science teachers do what they do when they teach science. First, I discuss how these findings shed light on the relationship between teacher education and the eventual classroom practice. Second, I describe how this study adds an additional perspective to our understanding of the influence of systemic reform on novice teachers. Third, I discuss how this study adds to our knowledge of the relationship between context and practice. Finally, I provide implications for both teacher education and for future research.

Chapter 2: Literature Review

This chapter will provide a review of the literature relevant to teacher cognition and the relationship between cognition and practice. Settlage (2013) suggests any study that looks at teacher thinking has, at minimum, an implicit view of how teacher thinking is translated into teacher action, and asks for researchers to come clean on their theoretical commitments that translate teacher thinking into classroom practice. As such, I first detail the theory of cognition that guides my work, acknowledging my commitment to representation at the heart of cognition. The remainder of the chapter will review the literature on teacher cognition, guided by the three types of representations—mediating states, environmental states, and goal states, respectively.

A Representational Theory of Teacher Cognition

Within cognitive science, there are two underlying assumptions within the field that ground any theory of human cognition. The first assumption is that cognition is processing of information contained within the mind resulting in a cognitive output. This output can be behavior, the input into a new cognitive process, or learning (Dietrich & Markman, 2000; 2003; Hutchins, 1995; Markman & Dietrich, 2000a; b; Marr, 1982; Pylyshn, 1980). The second assumption postulates internal states that contain semantic information which are included in cognitive processes. These internal states, or representations, are also common across theories of human cognition (Marcus, 2000; Markman, 1999; Markman & Dietrich, 2000b). Cognitive processes act over representations containing three types of information, which Markman & Dietrich

(2000b) classify as mediating states, environmental states, and goal states. I detail each of these elements below.

Mediating States

Mediating states are representations of a person that carry information about something (Markman & Dietrich, 2000b). Mediating states can correspond to things occurring in the present, as well as things removed in both time and space (Markman & Dietrich, 2000b). Mediating states often correspond to physical things (i.e. a person or an object), but also represent: knowledge and facts (DNA is contained in the nucleus); beliefs (I believe all students can learn); ideas and emotions (love or anger); and fictitious things that have never existed (zombies or phlogiston) (Markman, 1999; Markman & Dietrich, 2000b). As Markman and Dietrich (2000b) note, the description of a mediating state is purposefully general, as their commitment is to the notion “that there is internal information that mediates between environmental information coming in and behavior going out” (p. 145). Further, it is the notion of mediating states that distinguishes cognitive science from behaviorism and other psychological theories (Marcus, 2000; Markman & Dietrich, 2000b).

Mediating states can exist at different grain sizes, or levels of specification (Markman & Dietrich, 2000b). Thus, the mediating state “student” can be an abstract notion regarding students in general, a more specific idea regarding students in the school where one teaches, or even specified to the degree that it corresponds to one particular student in a teachers 4th period Earth science class.

The idea of a mediating state provides additional utility for research on teacher thinking, as it resolves the lingering question of the distinction between belief and knowledge. As many researchers have pointed out, it is difficult to determine where belief ends and knowledge begins (Abell, 2007; Fonseca, Costa, Lencastre, Tavares, 2012; Gess-Newsome, 1999a; 199b; Pajares, 1992; Peterson, Fennema, & Carpenter, 1991; Richardson, 2003). As Gess-Newsome (1999b) describes the problem, "making distinctions between aspects of teacher's knowledge and beliefs is heuristically convenient for the study of teaching, though flawed in the potential misrepresentation of the dynamic interplay between the constructs that we wish to describe (p. 55). Furthermore, because of the complexity of these terms, there is lack of agreement among definitions by researchers, adding to the confusion within the field (Gess-Newsome, 1999a; Richardson, 2003).

Within the model of cognition framing this study , the confusion is cleared up, as beliefs and knowledge are treated as different flavors of the same class of representations: mediating states. While recognizing there are differences between belief and knowledge, such as the different epistemological footings that beliefs and knowledge rest on (Richardson, 2003), this distinction is more of a taxonomic tool for researchers studying teacher thinking (Gess-Newsome, 1999b). Within the representational model, beliefs and knowledge function in the same way in cognitive processes by mediating between information drawn from the environment and cognitive outputs. Thus, knowledge and beliefs are joined by a host of other representations as mediating states, including, but not limited to, attitudes, emotions, and ontological and epistemological understandings.

This is not to say that mediating states are idiosyncratic in nature. Instead, there is often a high degree of social influence on individual mediating states, leading to congruence of the mediating states of individuals in social settings (Alterman, 2007; Echterhoff, Higgins, & Levine, 2009; Garrod & Anderson, 1987; Garrod & Doherty, 1994; Hutchins, 1995; Kovacs, 2010). Language and communication play a large role in the organization and content of mediating states (Garrod & Anderson, 1987; Markman & Makin, 1998; Slobin 1996). There is a reflexive relationship between the two: increased communication will increase the congruence of individual mediating states in a community, and the greater the degree of congruence between the mediating states of two people, the easier it is to engage in complex communication.

Congruence is not limited to basic semantic content, such as everyone agrees that grass is green. Social influences can be exerted on complex cognitive tasks as well (Gardenfors, 2000; Hutchins, 1995; Markman & Makin, 1998). For example, Alterman (2007) and Garrod and Pickering (2009) both conclude that collaboration in work environments leads to shared mediating states regarding the task each individual is to undertake. In other words, when teachers collaborate in their work environment, they develop a shared set of mediating states regarding what good teaching looks like in the school.

Environmental States

Early theories of cognition assumed the whole of cognition took place within the brain. In essence, cognition could be explained via appeal to mediating states alone[2]. More recent theories of cognition suggest that in explaining cognition and behavior, we must take into account the setting in which a person finds themselves (March & Simon, 1993; Markman, 1999; Packer & Winne, 1995; Ross & Nisbett, 1991). As such, the model of cognition used herein takes into account the setting via environmental states, which are representations containing information drawn from the environment used in cognitive processes (Markman & Dietrich, 2000b).

Environmental states can take the form of physical location (I am in my classroom) that both constrain or enable various behavior and cognitive processes (March & Simon, 1993; Packer & Winne, 1995; Ross & Nisbett, 1991). For example, a chemistry teacher would not engage the behavior of setting up a lab if they are not in their school. Barnett and Hodson (2001) further explain how very different settings can engage very different types of behavior, driven by different dispositions for the same person. Within the school setting, a chemistry teacher, required to float between classrooms, may implement very different classroom curricula when they teach in a chemistry lab than when they teach in an English room. The school setting provides environmental information that the teacher can draw upon.

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2 Note that mediating state is a term that arose in response to theories of situated cognition. Thus, while early theories of cognition relied solely on mediating states (as defined by Markman and Dietrich, 2000), they did not label such representations as mediating states.

Another part of the physical environment that produces environmental states are artifacts (Hiebert & Morris, 2012; Hutchins, 1995). As Hiebert and Morris (2012) note, much of the knowledge required for effective teaching can be offloaded onto physical artifacts, such as text books and lesson plans. Thus, instead of encoding an entire lesson plan in memory as a mediating state, much of the lesson can be offloaded onto a physical lesson plan, and drawn upon as an environmental state. What is required to store in memory for this cognitive process then is just where one placed the lesson plan in order to read it.

The physical nature of environmental states plays a spatial and temporal role in cognition. A person can create a physical space or artifact that then influences the cognition of another person in a different place, at a later point in time. This implies that design of schools and classrooms has a powerful influence on all teachers who work within the space. And, the design of curricular artifacts, such as pacing guides or laboratory guides, can also have a powerful impact on the teachers who use them.

Yet, there are more subtle, less tangible, influences on teacher cognition via the environment. Social influences, such as culture are a powerful set of environmental states (Hutchins, 1995), particularly if and when a person inhabits multiple subcultures. While cultural expectations themselves may be mediating states, presence in a cultural setting is a very powerful environmental state. As an example, the same person can inhabit a work culture as an employee as well as a university culture as a graduate student. Furthermore, the same set of behaviors, such as wearing shorts and a t-shirt, can be appropriate in one cultural setting while inappropriate in a second.

March and Simon (1993) and Hutchins (1995) note that division of labor is a powerful influence on individual cognition. Division of labor, they say, directs attention toward some things and away from others. Within the school setting then, division of labor often directs the attention of science teachers toward those things related to science teaching, and away from things unrelated to science. Thus, a science teacher who ignores a student's question regarding the U.S. Constitution may not regard the question as a proper environmental state, and discards it from cognitive processes.

Related to the notion of division of labor is the issue of role relations. Ross and Nisbett (1991) remark on the powerful influence role relations have on cognition and behavior. Referencing, among other things, the Milgram experiments, they suggest that occupying a specific role in a social situation provides a powerful environmental state on how to act, driving cognition and behavior, and suppressing mediating states that might cause people to act differently (Ross & Nisbett, 1991).

Language also acts as a supply of powerful environmental states (Slobin, 1996). First, labeling and categorization can act as powerful environmental states. Marcus (2000) mentions that categorization treats all members of the group equivalently. Thus, labeling a student as gifted, special education, English language learner, or one of a host of other categories, induces a powerful environmental state in those who use the category. Information relevant to their being in the category (i.e. test scores) is highlighted, while information irrelevant to the category (likes to read science fiction) is suppressed. Not only is the process of categorization itself an environmental state, but the label provides an additional environmental state. Thus, while the category of "all students who didn't pass the science test by one or two questions" is a category that will influence cognition and behavior of teachers working with students in such a category, the choice of label will also influence the cognition and behavior of the teachers. Thus, choosing to call these students "bubble kids" versus "opportunity students" versus "lazy and unmotivated" will have profound effects on how teachers work with such students.

The framing of situations both within metaphorical thinking and more generally can also have implications for how people act (Kahneman, 2011; Tennbrunsel & Messick, 1999). LeBoeuf and Shafir (2005) and Tversky and Kahneman (1981) both suggest that people accept problems as they are framed. Thus, the problem framing is the environmental state, and people draw upon mediating states in relation to solving the problem with which they are presented. A principal stating that a school has bad test scores because of classroom management is a powerful frame, and people often will not consider alternative frames, such as bad test scores result from lack of culturally relevant pedagogy.

Goal States

There is broad consensus across current models of cognition suggesting that cognition is goal directed (Aarts & Elliott, 2012; Carver & Scheier, 1998; Gollwitzer & Moskowitz, 1996; Locke & Latham, 1990; Markman & Dietrich, 2000b; Moskowitz, 2012; Shah & Kruglanski, 2007). That is, during cognitive processes there must be representations that carry information representing desired future states of the environment (Aarts & Elliott, 2012; Aarts & Dijksterhuis, 2000; Altmann & Trafton, 2002; Carver & Scheier, 1998; Fujita & MacGregor, 2012; Markman & Brendl, 2000;

Markman & Dietrich, 2000a; b; Sheeran & Webb, 2012). Markman and Dietrich (2000b) call these representations goal states. Aarts, Gollwitzer, and Hassin (2004) suggest that goals states can represent both behavior in which the person will engage (do example problems on Newton's Laws), as well as a desired outcome (students learn how to solve the equation F=ma). Carver and Scheier (1998) further suggest that goal states can also represent things a person wants to avoid (classroom disruptions).

Goals are a particularly relevant component of cognitive processes during choice and decision making. Markman and colleagues (Markman & Brendl, 2000; Markman, et al., 2000) propose that goals influence both the mediating states and environmental states to be used during a cognitive process. As Markman and colleagues (2000) suggest, attributes of various possible choices and courses of action are defined and measured relative to the active goal. Furthermore, Barsalou (1983) and Markman and Makin (1998) recognize ad hoc, or emergent, categories, which are taxonomic groups that emerge naturally from the creation of a new goal.

At any given time, people are often pursing a number of different goals. Furthermore, the goals influencing cognition at any given time need not be consistent with each other (Fishbach & Shah, 2006). A basic example is that the goal for eating pizza and being on a diet might both be present at dinner time. When multiple goals are inconsistent, people must resolve this tension in some way, either via modification of or disengagement from one or more goals (Gollwitzer & Moskowitz, 1996). Fishbach and Shah (2006) continue that the situation also influences the relative consistency of multiple goals. In one setting, goals may be mutually reinforcing, while in another setting, they are inconsistent.

In the absence of situationally consistent goals, chronically active goals will be used in cognitive processes (Markman & Brendl, 2000). One of the most influential chronically active goals is loss aversion (Kahneman, 2003; 2011; LeBoeuf & Shafir, 2005). People are inherently risk averse, whereby decisions are made relevant to the current status quo. Risk aversion manifests itself when deciding about a course of action that would be equally likely to, for example, increase test scores by one question or decrease test scores by one, the loss of one question looms larger than the possibility of the equal gain. Thus, loss aversion will guard against taking such action. Kennedy (2005) notes that teachers "may feel a greater sense of urgency to avoid those things they fear than to accomplish the things they hope for" (p. 41). In other words, a teacher's classroom practice may be driven by goals reflective of things to avoid as well as goals reflective of things to accomplish.

Goal Hierarchies and Long Term Goals

People often use the term goal to represent outcomes that they hope to achieve in the long term. For example, a teacher might have the goal of students passing a standardized test at the end of the year. Yet, Markman and Brendl (2005) acknowledge that goals are quite specific contextually and temporally. Markman, Brendl & Kim (2007) further suggest that goal states carry a one-to-one relationship between the goal itself and the action required to achieve the goal. Long term goals, such as having students pass a standardized test, often require multiple actions to be undertaken at multiple points in time.

In an effort to distinguish between specific and abstract goals, Markman and Brendl (2005) introduce the term cognitive policy[3]. As described by Hutner and Markman (under revision), “cognitive policies are broad, consciously accessible generalizations regarding longer-term outcomes an individual is striving toward and the required behavioral actions that might support such an outcome” (p. 12). The notion of a cognitive policy is congruent with much of the literature on goal hierarchies, with specific goals at the lower level of the hierarchy and more broad, abstract and longer term goals at higher levels (Boekaerts, et al., 2006; Carver & Scheier, 1998; Gollwitzer & Moskowitz, 1996; Moskowitz, 2012; Shah & Kruglanski, 2007). The notion of goal hierarchies, and the relationship between goals and cognitive policies will be expanded upon in much greater detail in chapter 3.

Within the context of teaching, pedagogical approaches are often framed as cognitive policies. This includes both traditional approaches to teaching, such as lecture and note taking, and constructivist, reform minded approach such as inquiry and project-based instruction (PBI). For example, Saka, Southerland and Brooks (2009) report on the case of Nathan, who:

[3] Originally, Markman and Brendl use the term “policy” to identify these types of mediating states. To distinguish between the policies used in cognition and formal policy created by government and other organizations, Hutner and Markman (under revision) use the term “cognitive policy.” I follow this convention.

> Understood reform based, student-centered methods as the most effective way to help students understand how science interplays with their lives. At this time, Nathan's goal was to teach through reform-based science methods. Nathan explained, "I like [the reform documents]. I think they're flawed and I think they're not perfect, [but] I think they're good starting point. I think they're the best, coherent vision we have for science for all Americans" (p. 1006).

In this instance, both Nathan himself as well as Saka, Southerland and Brooks frame Nathan's preferred pedagogy as guiding cognitive policies. While Nathan wanted to teach in accordance with the reform documents, this statement is too broad to result in any specific action. Thus, Nathan is expressing a cognitive policy—reflective of a desire to teach in a way reflective of the reform documents—which can only be realized in classroom practice via more specific goals.

Cognitive Processes

The last element of this representational theory of cognition is cognitive processes. All theories of cognition that rest on representations "implicitly include certain aspects of processing operations in the representation itself. Without those processes, the representation is meaningless" (Palmer, 1978, p. 264) Cognitive processes take the three representational elements—mediating states, environmental states, and goal states—and translate them in such a way to produce cognitive and behavioral outputs (Ericsson & Simon, 1993; March & Simon, 1993; Markman, 1999; Markman and Dietrich, 2000b). There exist many theories of cognitive processes, including, but not limited to, semantic networks (Anderson, 1983b; McClelland & Rumelhardt, 1981), featural process (Smith, Shoben, & Rips, 1974; Tversky, 1977), and scripts or schemas (Schank, 1982; Schank & Abelson, 1977). What these all have in common is the requirement to act upon the three elements that contain information.

Another similarity to all theories of representation is the recognition that humans have limited cognitive capacity (Dietrich & Markman, 2000b; Kahneman 2003; 2011; LeBoeuf & Shafir, 2005; March & Simon, 1993; Simon 1985). People cannot attend to everything in their environment at once. Nor are people able to bring the entirety of their mediating states to bear on any cognitive process. People also do not pursue every goal they have at once. While there are many approaches to solving this problem, the notion of activation is also similar across theories of cognition.

Activation

There is a broad consensus in cognitive science that only those representations that are active at any given time are used in cognitive processes (Anderson, 1983a; 1983b; 1991; Carver & Scheier, 1998; Eitam & Higgins, 2010; Higgins, 1996; Higgins & Brendl, 1995; Kahneman, 2003; 2011; March & Simon, 1993; Markman & Brendl, 2000; Markman, Maddox, & Baldwin, 2005). Activation is similar to the concept of working memory, in that just as there is an upper bound on the number of slots that can hold something in working memory, there is a limit on the amount of activation that can spread through the various representational elements (Anderson, 1983a; 1983b). However, activation is different from working memory, in that activated states do not need to be consciously accessible to be included in cognitive processes (Aarts, Gollwitzer, & Hassin, 2004; Nisbett & Wilson, 1977; March & Simon, 1993; Markman, Maddox, & Baldwin, 2005).

Higgins and colleagues point out that there are multiple routes in which a representation can be activated (Higgins & Brendl, 1995; Eitam & Higgins, 2010; Higgins, 1996). The first way is through repeated use of a specific representation. The more often someone draws upon a representation, the more easily that representation will be activate in ensuing cognitive process. Thus, a physics teacher is likely to activate concepts such as Newton's Laws when thinking about teaching, because they use Newton's Laws frequently.

A second way that a representation can become active is via a deep personal commitment to a specific representation. Thus, a science teacher holding a deep commitment to argumentation strategies is likely to activate representations related to argumentation when planning lessons.

The third way a representation can become activated is via applicability to the current setting and situation. In this pathway, representations that are semantically related in some way to currently active representations are likely to become active. Thus, a chemistry teacher planning a lesson on Lewis acids and bases is likely to also activate representations corresponding to Bronstead-Lowry acid/base theory, while being less likely to activate representations concerning the ideal gas law.

Explaining Cognition

Figure 2.1, on the next page, is a graphical representation of the theory, showing the relationship between these elements in teacher cognition, as well as the types of semantic content contained within each state.

There exists a reflexive relationship in the activation between the three semantic states to be included in any given cognitive process. The activation of one state will lead to the activation of other, related states. Thus, active goal states will activate mediating states that are likely to be useful in the attainment of the active goal. An active goal will also direct attention toward potential affordances for or constraints preventing goal attainment in the environment, activating specific environmental states from the plethora of information that could be drawn from the environment.

At the same time, active mediating states are able to activate related goal states. Thus, a strong belief in inquiry, for example, can activate goals related to teaching via inquiry. Similarly, environmental states can activate goal states, particularly if the environment provides affordances for goal attainment. As an example, a teacher entering his or her classroom to see the fume hood has been fixed will activate an environmental state corresponding to a fixed fume hood. This may then lead to the activation of goals related to doing demonstrations where noxious gasses are created. And, mediating states and environmental states can activate each other, as well. Lastly, all of this can happen consciously via an effortful cognitive process. Or, they can occur effortlessly, with little conscious attention given to the process.

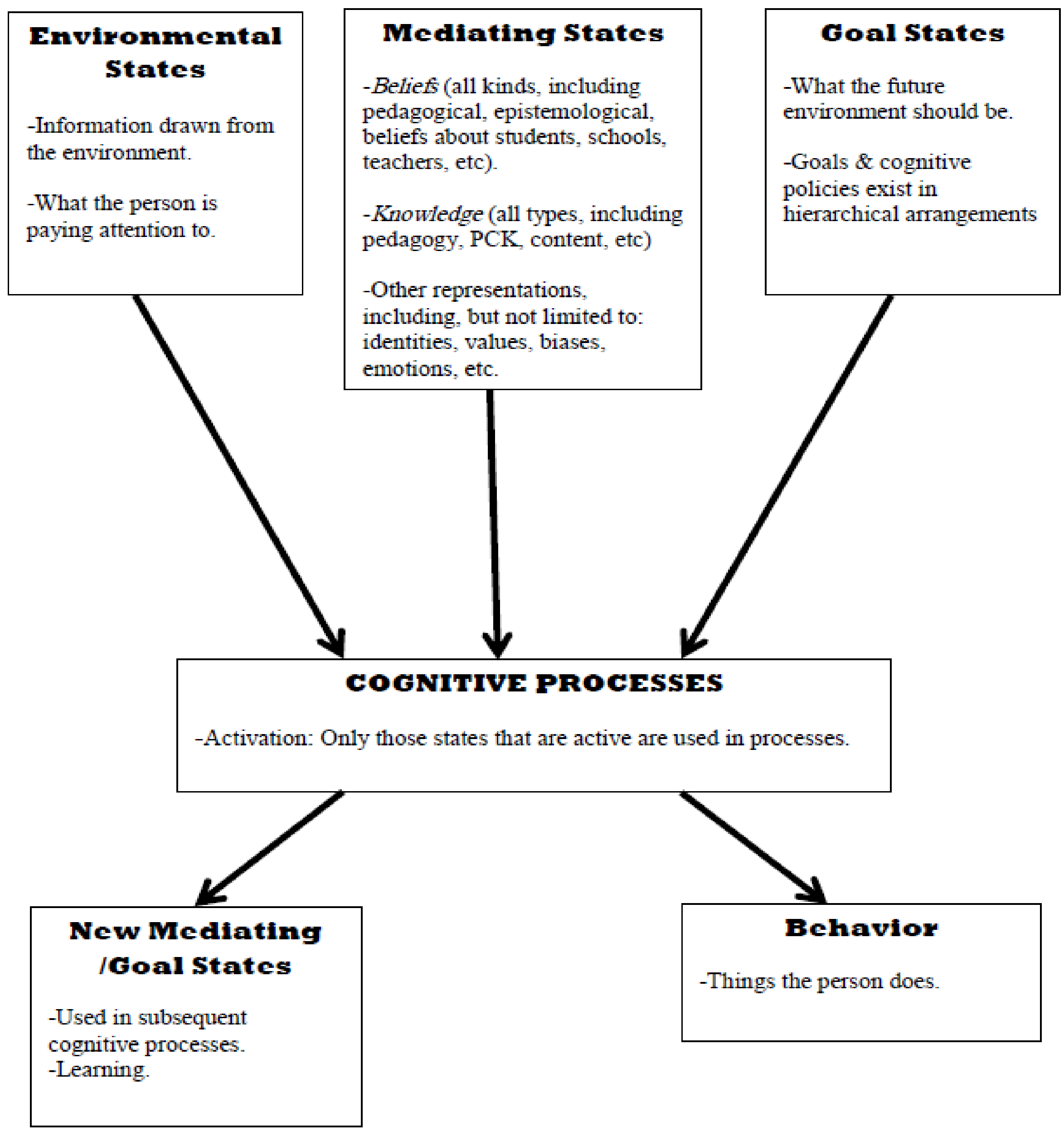

Figure 2.1: Representational Model of Teach Cognition (adapted from Hutner & Markman, under revision)

The previous discussion lays out the theory of teacher cognition that frames the remainder of this chapter, as well as provides the theoretical underpinnings for understanding the relationship between teacher cognition and teacher action. Further, recall that one of the driving questions for educational research is understanding why teachers do what they do (Abell, 2008; Tobin & McRobbie, 1999). In light of this question, I now elucidate the research that has been done on each of the three representational elements.

RESEARCH ON TEACHERS MEDIATING STATES

Beginning in the late 1970s researchers across education disciplines began to examine the cognition of teachers as a key facet to both understanding why and reforming what teachers do in the classroom (Grossman, 1990; Richardson, 2003). In moving from the behaviorist paradigm to a more cognitive one, researchers ground their work in the assumption that teacher actions are guided by their thoughts, beliefs, and knowledge before, during, and after the act of teaching (Artiles, Moster, & Tankersley, 1994; Fang, 1996; Fenstermacher, 1980; Manning & Payne, 1993; Kennedy, 1998; Pajares, 1992; Rozelle & Wilson, 2012; Shavelson & Stern, 1981). In other words, researchers focused heavily on the mediating states of teachers, and the relationship between mediating states and a teacher's actions within the classroom. In this section, I review the relationship between a teachers mediating states and their classroom practice.

Beliefs

As summarized by Roehrig, Kruse and Kern (2007), "there is a clear statistical relationship between teachers' beliefs about teaching and learning and their classroom practice during the implementation of the reform-based curriculum" (p. 9). More simply, a teacher's beliefs lead to his or her classroom practice. In light of this, if science teachers are to carry out the vision of science teaching and learning contained in documents such as *Science for All Americans* [American Association for the Advancement of Science (AAAS), 1990]; *The National Science Education Standards* [National Research Council (NRC), 1996] and the *Framework for K-12 Science Education*[4] (NRC, 2012), they must hold belief sets reflecting and supporting the pedagogical approaches advocated therein.

While acknowledging the historical variability in precise definitions of beliefs (Gess-Newsome, 1999b), beliefs are often defined as personally held constructs that do not necessarily need to be grounded in an evidentiary basis (Kagan, 1990; Luft, et al., 2011; Luft & Roehrig, 2007; Manning & Payne, 1993; Richardson, 2003; Roehrig, Kruse, & Kern, 2007). Teacher beliefs are typically used to refer to these personal constructs as they relate to teaching, learning, students, schools, and subject matter (Kagan, 1990; Pajares, 1992), but can also refer to things other than concepts directly related to education (Pajares, 1992). Beliefs can be explicitly known and verbalized, or they can be held implicitly, inaccessible to conscious thought processes (Verjovsky & Waldegg, 2005).

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[4] For the remainder of this manuscript, these three documents will often be collectively referred to as "the current reform movement in science education." Furthermore, I use the term "reform-oriented" to refer to pedagogical approaches congruent with these documents. While recognizing that over 20 years passed between the release of these documents, there is considerable overlap in their overarching purpose: to lay a foundation for a high-quality science education experience for all students "regardless of age, sex, cultural or ethnic background, disabilities, aspirations, or interest" (NRC, 1996, p. 20).

Beliefs are often not isolated from each other, but instead exist in interconnected networks (Fonseca, et al., 2012; Pajares, 1992; Sanger & Osguthorpe, 2011; Thomson, Turner, Nietfeld, 2012; Verjovsky & Waldegg, 2005). Thus, beliefs may be dependent on other beliefs for their meaning, including beliefs not related to schooling or subject matter (Pajares, 1992). Because of this interconnectedness, teacher beliefs are often quite stable over time, as reappraisal of one belief may require the reappraisal of a set of beliefs together (Pajares, 1992; Russ & Luna, 2013).

Furthermore, currently held beliefs filter the perception of and response to new information, for both in-service and preservice teachers. In-service teachers, for example, interpret new policy inputs in ways that are influenced by and consistent with their currently held belief sets (Anderson, 2012; Spillane, Reiser & Gomez, 2006; Spillane, Reiser, & Reimer, 2002). For example, Penuel, Fishman, Gallagher, Korback, and Lopez-Prado (2008) found "when teachers believe curricular activities will not prepare students to do well on assessments of student learning for which schools are held accountable, teachers may choose not to implement" (p. 2). There is a growing body of literature supporting and extending this idea, suggesting that, despite the neutral approach to curriculum and pedagogy contained within accountability policy movements, science teachers often believe that inquiry-based approaches are not congruent with the approaches emphasized via state standards and high-stakes tests (Anderson, 2012).

With respect to preservice teachers, findings indicate that preservice teachers enter their teacher education program with well-formed beliefs about teaching and learning (Abell & Flick, 1997; Achinstein, Ogawa, & Speiglman, 2004; Belo, Van Driel, van Veen, & Verloop, 2014; Bodycott, Walker& Kin, 2001; Lortie, 1975/2002; Richardson, 2003; Settlage, Southerland, Smith & Ceglie, 2009). Similar to in-service teachers, preservice teachers assimilate teacher education via currently held beliefs (Joram & Gabriele, 1998; Wang, Spalding, Odell, Klecka, & Lin, 2010). Furthermore, preservice teachers often come with beliefs supportive of traditional, transmission based pedagogical practice. “If a teacher candidate believes that knowledge can be transmitted from the mind of the teacher to the mind of the students, in a manner of injection, pedagogical practices based upon constructivists theories are unlikely to be adopted” (Raths & McAnninch, 2003, p. vii). Because preservice science teachers often enter teacher education with beliefs supporting lecture based classrooms, their learning during teacher education will be shaped by and, often supportive of, transmission oriented beliefs.

Recognizing this, there is a concerted effort within teacher education to make the belief sets of teachers explicit (Darling-Hammond, 2006; Manning & Payne, 1993; Richardson, 1996a; b). Drawing on the interconnectedness of beliefs, the focus is on changing the belief sets, as superficial engagement with isolated beliefs is unlikely to lead to the changes desired by teacher educators (Richardson, 2003). Richardson (2003) and Luft and Roehrig (2007) both find that beliefs are often quite difficult to change, despite the best efforts of teacher educators and teacher education programs as a whole. Yet, Southerland, Sowell and Enderle (2011) counter that with sustained effort and support, teacher beliefs can change and move in the direction of supporting reform based pedagogy and practices.

The current era of reform in science education has focused on belief change for preservice and in-service teachers related to multiple domains. First, professional development at all levels seeks to foster in teachers a belief that inquiry-based instruction is effective and beneficial for students (Luft, et al., 2011; NRC, 1996; 2000). The belief in inquiry based practice is part of a holistic movement to help preservice and in-service teachers develop robust belief sets regarding the nature of science. For example, Jones and Leagon (2014) note that epistemic beliefs about scientific knowledge, including "justification of their knowledge in science (e.g. handed down by authority or derived from reason) can be a pivotal factor in making curricular decisions" (p. 836). A teacher's willingness to use inquiry is not only determined by their belief in the effectiveness of inquiry, but also their beliefs about the role inquiry plays in the production of scientific knowledge.

Similarly, teachers need to hold appropriate beliefs regarding their students if they are to enact the vision of science education promoted via current reform efforts. First, teachers must believe that all students are capable of learning, engaging in inquiry, and understanding scientific knowledge (Lee & Buxton, 2010; Woodbury & Gess-Newsome, 2002). Teachers beliefs related to race, class, and gender can impact classroom management, curriculum, and class dialogue (Jones & Leagon, 2014). As suggested by Raths and McAnninch (2003), there is no evidence that students entering teacher education will hold more egalitarian or equitable beliefs about students than the population as a whole. Thus, teacher educators spend a great deal of time providing support for teachers to confront and reflect upon their beliefs about students.

Knowledge

As the study of teachers and teaching moved from a behaviorist to a cognitive paradigm, the knowledge of teachers moved front and center for those seeking to reform science teaching and learning (Alonzo, Kobarg & Seidel, 2012; Barnett & Hodson, 2001; Darling-Hammond, 2006; Kennedy, 2005; Magnusson, Krajcik, & Borko, 1999; Shulman, 1986; 1987; Strike, 1993; Sykes, 1983). As Magnusson and colleagues (1999) point out "planning and teaching any subject is a highly complex cognitive activity in which the teacher must apply knowledge from multiple domains" (p. 95). The domains that Magnusson and colleagues were referring to were those set forth by Shulman (1987). Shulman (1987) suggested that effective teachers drew from a set of seven knowledge bases: "(1) content knowledge; (2) general pedagogical knowledge; (3) curriculum knowledge; (4) pedagogical content knowledge; (5) knowledge of learners (i.e. students); (6) knowledge of educational contexts; and (7) knowledge of educational ends" (p. 8).

Below, I review the literature on content knowledge, pedagogical content knowledge (PCK), and knowledge of learners, as these have been the more popular of the research avenues within the field of science education.

Content Knowledge

The first of Shulman's (1987) knowledge bases that effective teachers draw upon is content knowledge. The rise in popularity of cognitive theories for understanding a teacher's classroom practice at the time Shulman proposed his knowledge bases "brought renewed interest in the nature and influence of teacher content knowledge" (Gess-Newsome, 1999b, p. 52). Teacher educators caution against a simplified view of content knowledge as a list of facts to be learned by preservice teacher candidates. While scientific facts, laws, and theories are part of content knowledge, a teacher must also:

> Understand the structures of subject matter, the principles of conceptual organization, and the principles of inquiry that help answer two kinds of questions in each field: What are the important ideas and skills in this domain? and How are new ideas added and deficient ones dropped by those who produce knowledge in this area (Shulman, 1987, p. 9)

Thus, a teacher must have an understanding of not only what the current status of his or her field is, but how knowledge within the field develops over time.

There is broad consensus that in order to promote reform-oriented science teacher and learning, teachers need robust understanding of the content they are to teach (Abd-El-Khalick & BouJaoude, 1997; Ball, Thames & Phelps, 2008; Gess-Newsome, 1999b; Houseal, Abd-El-Khalick, & Destefano, 2014; Kennedy, 1998; Kind, 2009; Magnusson, Krajcik, & Borko, 1999; Olson, 2008; Sadler, Sonnert, Coyle, Cook-Smith, & Miller, 2013; Sockett, 2008). Furthermore, content knowledge exerts a strong influence on the daily practice of teachers (Bartos & Lederman, 2014; Crawford, 2007; Kind, 2009). As examples, Carlsen (1993) and Crawford (2007) found a positive relationship between content knowledge and classroom discourse. Hashweh (1987) and Kind (2009) both found that increases in teachers' content knowledge lead to increases in the robustness of their pedagogical and curricular choices.

Conversely, a lack of content knowledge often results in teacher centered classrooms with limited opportunities for students to actively engage with scientific ideas and practices (Childs & McNicholl, 2007; Davis, Petish, & Smithey, 2006; Gess-Newsome, 1999b; Van Driel, Berry, & Meirink, 2014). According to Gess-Newsome (1999b), poor content knowledge often results in pedagogical approaches focused on acquisition of facts and the ability to correctly solve algorithms. A subset of this research focuses on the issue of content specialism in science. A science teacher may have a deep understanding of the content knowledge in their area of specialization (i.e. biology), yet possess only a surface level understanding of scientific content in other areas (i.e. physics). As Childs and McNicholl (2007) note, "when teaching outside subject specialism, in many respects, even our experienced teachers felt deskilled and novice-like" (p. 13). In other words, the findings suggest that when teaching out of specialism, teachers often revert to the traditional approaches that are linked with poor content knowledge.

Given this, there is a concerted effort to increase the content knowledge of preservice teachers via an increased course load in their content area during teacher education. Unfortunately, despite the fact that "teachers may not be underprepared in terms of [collegiate content] coursework, in almost all of the studies reviewed here, the teachers were found to have unsophisticated understandings of science" (Davis, et al., 2006, p. 614). A more recent review by Van Driel and colleagues (2014), building upon and extending the review of Davis and colleagues (2006), found a preponderance of the literature suggesting novice teachers often have weak understanding of both the content as a whole as well as specific ideas within each discipline.

Not only do preservice and in-service science teachers generally have gaps in their content knowledge, but they often hold misconceptions similar to those held by K-12 students (Abd-El-Khalick & BouJaoude, 1997; Abell, 2007; Wandersee, Mintzes, and Novak, 1994; Sadler, et al., 2013). In response to this, teacher educators suggest confronting preservice and in-service teachers with their own misconceptions (Loughran, 2014; Sadler, et al., 2013; Settlage & Goldston, 2007). This allows them to both clear up lasting misconceptions and to gain awareness of the misconceptions their students are likely to hold.

*Knowledge of the nature of science and of scientific inquiry***.** As suggested by Shulman (1987), robust content knowledge includes ontological, epistemological, and methodological knowledge as well as knowledge of facts and theories. In other words, what are the foundational assumptions of a discipline and how does the discipline go about producing new knowledge while discarding outdated perspectives. The first two—ontology and epistemology—concern the nature of science, while the third—methodology—concerns scientific inquiry. While some suggest that these are two separate domains of knowledge (Bartos & Lederman, 2014), I draw from a Kuhnian perspective, suggesting that these three concepts are inherently intertwined, and cannot be dissociated from one another (Kuhn, 1996).

There is general agreement that preservice and in-service teachers must have a substantial understanding of the nature of science "because teachers' decisions about how and what to teach are affected by their understanding about the nature of science" (Coble & Koballa, 1996, p. 470). The nature of science includes content specific ideas, such as the structure and relationship between concepts, and which concepts are most central to a field (Bartos & Lederman, 2014; Davis, et al., 2006; Schwartz & Lederman, 2002). For example a teacher needs to know not only what Newton's Second Law is (F=ma), but also to what other concepts it is connected and why Newton's Second Law holds such a foundational place in physics.

Teachers also need to have an appreciation for the foundational assumptions of the nature of science (Abd-El-Khalik & BouJaoude, 1997; Crawford, 2007; Kennedy, 1998). By foundational assumptions, I refer to the knowledge of the scientific world view, where explanation from evidence is prioritized and one appeals to natural explanations for observed phenomena. It is for this reason that the nature of science and scientific inquiry are inseparable—one cannot make claims via an appeal to evidence without first defining what counts as evidence and how such evidence can be gathered (Kuhn, 1996).

As they are inseparable, teachers "must develop a thorough understanding of scientific inquiry" (Forbes & Davis, 2010, p. 8222). Davis and colleagues (2006) further contend that this knowledge is both conceptual and procedural: teachers need to not only understand what inquiry is, but also how to conduct inquiry as well. The importance of teachers understanding and being able to do inquiry is underscored by findings indicating a relationship between knowledge of and ability to inquire on one hand and the opportunities provided to K-12 students to engage in inquiry on the other.

Current research suggests that preservice and in-service teachers generally have undeveloped knowledge of both the nature of science and scientific inquiry (Abd-El-

Khalick & BouJaoude, 1997; Chowdhary, Liu, Yerrick, Smith, & Grant, 2014; Forbes & Davis, 2010; Jones & Leagon, 2014). Furthermore, both Abd-El-Khalick and BouJaoude (1997) and Gess-Newsome (1999b) suggest that concerted effort must be made to help teachers learn the nature of science and scientific inquiry, as this subset of content knowledge "does not appear to be a natural consequence of graduating [from college] within a specified discipline or result from teaching experience" (Gess-Newsome, 1999b, p. 68). Unfortunately, teachers tend to hold a "view of the nature of science as an objective body of knowledge created by a rigid 'scientific method'" (Wallace & Kang, 2004, p. 940), resulting in few opportunities for K-12 students to engage in scientific inquiry of their own (Chowdhary, et al., 2014).

Pedagogical Content Knowledge

In response to the cannon of research that shows the transmission model of teaching doesn't work, science teachers need not only to have sufficient content knowledge, but also knowledge of how best to represent such knowledge to students in a K-12 setting (Abell, 2007; Alonzo, Kobarg & Seidel, 2012; McDiarmid & Clevenger-Bright, 2008; Shulman, 1987). Referred to as pedagogical content knowledge (PCK), Shulman (1987) defines it as:

> The distinctive bodies of knowledge for teaching. It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction (p. 8).

PCK is, as Shulman (1987) reminded us, the difference between the teacher and the pedagogue, between the generalist and subject specific educator. Alonzo and colleagues (2012) also suggest that PCK is that which separates the domain specific expert teacher from subject matter specialists. Thus, the difference between a physics teacher and a physicist (including a physicist who may be forced to teach physics) is the development of physics specific PCK.

Some scholars regard PCK as its own branch of knowledge, separate from both pedagogical knowledge and subject matter knowledge (Magnusson, Krajcik & Borko, 1999), while others treat it as an emergent property of teaching that does not necessarily require a separate knowledge domain (Abell, 2007; De Jong, Van Driel, & Verloop, 2005). However, this debate too is largely a matter of semantics, as PCK is one of several types of mediating states that influence teacher cognition and practice in the classroom. Either way, there is almost universal agreement that reform based science teaching requires preservice teachers develop effective PCK during teacher education (Abell, 2007; Bransford, Darling-Hammond, & Lepage, 2005; De Jong, Van Driel, & Verloop, 2005; Grossman, 1990; Kang, Bianchini, & Kelly, 2013; Shulman, 1987; 1999).

Grossman (1990) identified four mechanisms that can influence the development of PCK in both preservice and in-service teachers: (1) subject matter education; (2) observation of other teachers; (3) teacher education courses; and (4) classroom experience. There are many, however, that counter that PCK is something teachers "can hardly learn from a textbook or short course only. To develop PCK, teachers need to explore instructional strategies with respect to specific topics in practice" (De Jong, et al., 2005, p. 947). Thus, of the four mechanisms identified by Grossman, classroom experience may be the most important influence on PCK development, as PCK is highly dependent on contextual understanding for effective use (Abell, 2007; De Jong, et al., 2005; Shulman, 1987).

The teacher education community further recognizes that there is still much research needed to fully understand PCK and the role of teacher education in the development of PCK in preservice teachers. Settlage (2013) points out two shortcomings. First, current definitions of PCK imply that there is a great deal of content knowledge that teachers hold that have no influence on PCK and teaching in K-12 settings. Thus, he questions how much content knowledge teachers must actually know in order to develop effective PCK. Second, and more importantly, Settlage (2013) finds it “troubling that the PCK literature is all but silent about diversity, multiculturalism, and equity” (p. 2). The implications are that the same PCK works for all students, or worse, teacher education promotes a certain type of PCK as a normative standard, thereby perpetuating deficit models as K-12 students don’t respond to the normative definition of PCK.

*The core practices movement***.** There is a movement afoot to, as described by Rozell and Wilson (2012), shift teacher education “away from helping teachers learn *about* teaching toward learning *to teach*, moving from knowledge to practice” (p. 12, emphasis added). The goal of the movement, referred to as core practices, is to help teachers learn specific, high-leverage practices that have been shown to produce K-12 student learning across diverse groups of students (Ball & Forzani, 2009; McDonald, Kazemi, & Kavanagh, 2013; Thompson, Windschitl, & Braaten, 2013; Windschitl, Thompson & Braaten, 2009; Zeichner, 2012). I review this movement as part of PCK, as the core practices advocates recognize there are content specific practices that have been shown to promote increased student learning at the K-12 level—an approach congruent with Shulman's (1987) insistence that pedagogy and content are inextricably linked (Ball & Forzani, 2009; Thompson, Windschitl, & Braaten, 2013; Windschitl, Thompson & Braaten, 2009).

Early efforts by Windschitl and colleagues (Windschitl, et al., 2009; Windschitl, Thompson, Braaten, & Stroupe, 2012) to identify core practices resulted in a set of "'meso-level' practices, meaning a set of instructional moves in which various micro-level practices…are strategically combined to allow students to participate in valued learning activities" (Windschitl, et al., 2009, p. 8). Via consultation with the literature, Windschitl and colleagues (2009; 2012) identified four core, or high leverage, practices: (1) constructing the big idea; (2) eliciting students' ideas to adapt instruction; (3) helping students make sense of material activity; and (4) pressing students for evidence-based explanations. A more recent effort by Kloser (2014) used the *Framework for K-12 Science Education* (NRC, 2012) as a roadmap to guide an expert panel to identify practices at the mirco-level as described by Windschitl and colleagues (2009; 2012). The core practices identified by Kloser (2014) are: (1) engaging students in investigations; (2) facilitating classroom discourse; (3) eliciting, assessing, and using student thinking about science; (4) providing feedback to students; (5) constructing and interpreting models; (6) connecting science to its applications; (7) linking science concepts to phenomena; (8)

focusing on core ideas, crosscutting concepts, and practices; and (9) building classroom community.

It is important to note that some may read this as implying teacher education no longer need to focus on teacher beliefs and knowledge. This is an overly behaviorist interpretation of the core practices approach, one that is not supported by a closer examination of the literature. As Zeichner (2012) notes, the core practices rely on a foundation of teacher knowledge, pedagogy, and PCK. Yet, they go a step further and help students connect those mediating states to actual reform oriented teaching practices. Thus, the role of teacher education shifts to a more supportive relationship, helping preservice teachers develop habits of *mind and action* that they can subsequently use upon entering the classroom.

Knowledge of Learners

Within science education, knowledge of learners has taken two directions: psychological knowledge of how people learn and more contextual knowledge on student characteristics. With respect to the psychological approaches to how students learn, “a teacher needs to know how students construct knowledge” (Coble & Koballa, 1996, p. 466)**.** Current theoretical approaches to teaching and learning suggest that students are not passive receptacles for knowledge, but instead must actively engage in the learning processes (Bransford, Brown, & Cocking, 1999; NRC, 1996; 2000; 2012). This knowledge is also likely to impact the degree to which a teacher uses inquiry, as those teachers who hold transmission views of knowledge are less likely to use in inquiry in their classes (Alonzo, et al., 2013; Crawford, 2007; Davis, et al., 2006).

Within science education, the psychological approach to learning also rejects the notion that students enter their science class as blank slates. Instead, they come with previously developed conceptions related to scientific knowledge (Bransford, et al., 1999; NRC, 1996; 2012; Strike & Posner, 1990; Wandersee, et al., 1994). Not only do students come to class with notions of scientific knowledge, but they often come with ideas that do not align with the current status of the field. For example, students often come to science class with the misconception that heavy objects fall faster, or that blood is created by the heart (Wandersee, et al., 1994). A recent study by Sadler and colleagues (2013) found the learning gains for students who had teachers with knowledge of these common misconceptions were greater than for students with teachers lacking in this knowledge.

Thus, science educators have rejected the notion that science learning is a transmission of knowledge to students, but instead promote a conceptual change approach to science teaching and learning (Posner, Strike, Hewson, & Gertzog, 1982; Strike & Posner, 1990). Under this paradigm, teachers need knowledge of both the misconceptions that students bring with them to class and effective strategies to help students identify and challenge their misconceptions. Part of actively constructing knowledge is for teachers to help students actively investigate and falsify their misconceptions, leading to conceptual change and the adoption of more scientific ways of viewing the world.

The second route for research on teacher's knowledge of learners is related to issues of equity. If a teacher is expected to teach in culturally responsive ways, they must have knowledge of the cultural backgrounds of their students and how those cultural backgrounds are similar and different from their own (Darling Hammond, Pacheco, et al., 2005; McDiarmid & Clevenger-Bright, 2008; Lee & Buxton, 2010). This is at the heart of Settlage's (2013) critique on PCK—namely that it downplays the cultural context of students as a factor in determining effective PCK. Rodriguez (1997; 2005) further mentions that leading efforts in science education reform often homogenize non-white students into "students traditionally underrepresented in science," further exacerbating the lack of knowledge of students that Shulman (1987) suggests is detrimental to quality teaching.

Furthermore, Moll, Amanti, Neff, and Gonzalez (1992) suggests that students bring with them funds of knowledge to the science classroom. When teachers are knowledgeable about the funds of knowledge students bring to the classroom, they are able to more easily bridge cultural divides, increasing the likelihood their students will experience success with in-school science. Often, however, teachers come to their science classes with deficit models of their students, which posits "that the student who fails in school does so because of internal deficits or deficiencies" (Valencia, 1997, p. 2). Deficit thinking, unfortunately, leads to a reduction in the quality of science teaching and learning.

The Apprenticeship of Observation

The final set of mediating states to review is the apprenticeship of observation. First identified by Lortie (1975/2002), the apprenticeship of observation recognizes that students have well-formed notions of good teaching given their extensive experience in K-12 classrooms as students (Abell, 2007; Abell & Flick, 1997; Achinstein, et al., 2004;

Darling-Hammond, 2006; Darling-Hammond, Banks, et al, 2005; Gregorie, 2003; Richardson, 2003). The apprenticeship of observation is a powerful set of mediating states—including both knowledge and belief, hence a separate section—that teachers bring with them to both teacher education and their eventual classroom. In simpler terms, science teachers teach science in a manner similar to how they learned science.

The apprenticeship can be based upon the culturally accepted definition of the role of “teacher”, as most adults have experience with public schools (Darling-Hammond, 2006). Or, the apprenticeship can draw upon notions of a particularly influential or memorable teacher (Pajares, 1992). Both serve to provide preservice teachers with strongly articulated notions of what good teaching looks like.

Common to most teacher education students, including but not limited to preservice science teachers, is an apprenticeship of observation based in traditional, didactic models of teaching and learning (Richardson, 2003). As there still exist large numbers of teachers who use a lecture and note taking approach to teaching, the apprenticeship of observation is likely to produce preservice teachers who hold transmission beliefs regarding the nature of learning (Abell, 2008; Barnett & Hodson, 2001; Richardson, 2003).

A second aspect of the apprenticeship of observation that preservice teachers experience regards the epistemological and ontological underpinnings of their subject matter (Gregorie, 2003). The traditional approach to science teaching portrays a positivist, authoritarian view of the nature of science. As there exist links between views on the nature of science and science teaching, these views serve in a supportive role to the didactic pedagogical approaches formulated via the apprenticeship. Further compounding this issue for science teacher educators is the reality that most undergraduate level science courses are taught using a didactic approach (Abd-El-Khalick & BouJaoude, 1997; Roehrig & Luft, 2006). Thus, subject matter courses at the collegiate level serve to reinforce the apprenticeship of observation.

The third aspect of the apprenticeship of observation is the hidden curriculum (Darling-Hammond, Banks, et al., 2005). The hidden curriculum of schools values different forms of student capital, thereby serving to reproduce inequality while appearing to be meritocratic (Bowles & Gintis, 1976). While preservice teachers may appeal to egalitarian aims, the hidden part of the apprenticeship leads them to reinforce the inequity that they hope to work against.

Recent policy developments have added a new wrinkle to the apprenticeship of observation. As high stakes accountability policies have swept across the country, teachers are responding with “a growing set of classroom practices in which test preparation activities are usurping a substantive curriculum” (McNeil & Valenzuela, 2001, p. 12). Brown (2010) further finds that most students entering teacher education now have had experience learning in school systems under the influence of these policies.

Fortunately (or unfortunately), the apprenticeship of observation is not a true apprenticeship. Lortie (2002) recognized the shortcomings of the apprenticeship: “students do not receive invitations to watch the teacher’s performance through the wings; they are not privy to the teacher’s private intentions and personal reflections on classroom events” (p. 62). Thus, as Darling-Hammond and colleagues (Darling-

Hammond, 2006; Darling Hammond, Banks, et al., 2005) have pointed out, the apprenticeship causes preservice teachers to focus on superficial, surface level aspects of teaching, thereby underestimating the complexity of teaching.

RESEARCH ON ENVIRONMENTS AND TEACHER'S ENVIRONMENTAL STATE

In this section, I review the role of the physical and social environment on teachers practice. Within the model of cognition laid out at the opening chapter, this section details environmental influences on teachers, but stops short of claiming these are the exact environmental states for teachers. In other words, in this section, I review research on the relationship between teachers as a whole and their physical and social environments, without making claims that every teacher will always act in the same way given a specific environmental context.

The Physical Environment

We cannot fully answer the question of why teachers do what they do without first examining the physical structure of the school (Amarel, 1983; Datnow, 2006, Siskin, 1995; Smylie, 1988). The layout of classrooms (i.e. is there a separate lab room, or does each room have a lab area?), the placement of classrooms geographically in the school (all science classes are in the same hallway, versus all grade level classes are in the same hallway), and the spaces (not) assigned for collaborative work are all among the ways the physical layout can influence the cognition of teachers within the school (Siskin, 1995; Smylie, 1988).

Furthermore, except for a small period in the 1970s, the logic behind the design of schools has remained remarkably unchanged in the past century of school reform

(Amarel, 1983; Cuban, 2009; Rothstein, 1998; Tyack & Cuban, 1995). This means for most teachers, the apprenticeship of observation was carried out in a space that bears striking resemblance to the classroom they will inhabit as a teacher. The mere presence in a classroom (an environmental state) is likely to activate mediating states linked to the apprenticeship of observation.

A second aspect of the physical environment that influences classroom practice is large class size, as teachers must work with upwards of thirty students in any given class (Darling-Hammond, 2006). Feldon (2007) suggests that in most instances, the number of students that a teacher must attend to during a class overwhelms their cognitive resources, thereby reducing their ability to think deeply about specific students or occurrences. Even when working with one or a small group of students, teachers are faced with a continuous stream of decision points. If they spend too much time on thinking about one thing, they run the risk of not attending to something else, of possibly greater importance.

While "larger classes sizes may be less expensive in some ways…they are not cost free" (Ingersoll, 2003, p. 150). Lipsky (2010) contends this cost borne by the school system is teachers giving priority to maintaining order within the classroom, a basic requirement for other learning activities to take place. As Kennedy (2005) puts it, this results in situation where "managing a [large] group can interfere with managing the ideas" (p. 18). Thus, larger class sizes often are accompanied by a reduction in the quality of teaching and learning that takes place in the classroom.

Curricular Artifacts

Possibly the most important aspect of the physical environment are curricular artifacts. As Forbes and Davis (2010) point out, “curriculum materials, which include instructional resources such as text books, lesson plans, and student artifact templates (i.e. worksheets) are important resources upon which teachers rely” (p. 820). Kauffman and colleagues (2002) point out that teachers rely quite heavily on curriculum guides provided to them by schools and districts. Schools and districts favor these curriculum guides, as it is a way to reduce the inequities in teacher quality: students get the same curriculum regardless of the teacher or even the school they attended.

At the same time, many argue that the curriculum guides are such powerful sources of information (i.e. environmental states) on teacher’s cognition that they reduce the degree to which teachers are asked to think and reflect upon their teaching (Barnet & Hodson, 2001; Davis, et al., 2006) Barnet and Hodson (2001) point out that in some cases:

> The curriculum is spelled out in remarkable detail, even to the extent of giving lesson-by-lesson directions, in an effort to render the curriculum “teacher proof”…By these means, the teachers is reduced to the role of technician, whose job is merely to operationalize the plans of others, teach in a way prescribed by others, and asses students’ learning in a way that is designated by others (p. 427-428).

Along with lesson-by-lesson instructions, schools and districts will provide pacing guides, such that teachers are not only provided with the "what" to teach, they are told when to teach it (Ingersoll, 2003).

Resources

A third influence of the physical environment on teachers is that of the physical resources available to teachers. Kennedy (2005; 2006a) notes that teachers rely heavily on props and other physical resources to enable and enhance their curriculum. The (in)ability of schools to provide the physical resources necessary for teaching provide important affordances and constraints on teachers (Forbes & Davis, 2010; Johnson & Birkeland, 2003; Kennedy, 2005; 2006a; 2010). Woe is the teacher who arrives to school only to find the copy machine broken.

The requirements for physical resources are particularly acute for science teachers, as the *Framework* requires all student to engage in scientific practices, including carrying out investigations and collecting data (NRC, 2012). Siskin (1995) and Forbes and Davis (2010) both point out the importance of materials for science classes, and that the presence, or lack thereof, of inquiry-based resources is a strong determinant of the degree to which a science teacher uses inquiry approaches in the classroom. This issue is compounded via a schools limited budgets, such that science teachers may have difficulty replacing equipment on a year to year basis, particularly if a principal does not allocate necessary funds for science. For example, if the gas line to a chemistry classroom leaks, the ability to carry out certain labs may be fundamentally restricted.

The lack of resources may also influence the relationship between teacher education and in-service practice. If, during preservice education, teachers learned under a condition of vast resources, the mediating states they create may be deeply rooted in these ideal conditions of the university. When faced with the resource constraints, the environmental states required to produce certain classroom practices are not present. Teachers may then have to resort to a backup plan, which is often the apprenticeship of observation.

Social Influence

The social context for teaching is an equally important influence on teachers practice. Below, I review literature on the social context and the relationship between the social aspect of schools and the practice of science teachers.

Organizational Culture

All organizations have a culture, or "a distinctive way of viewing and reacting to the…world (Wilson, 2000, p. 27). Organizational culture is also path dependent, in that decisions that shape the organizational ethos early in the life of the organization become stable and ingrained over time (Allison & Zelikow, 1999; Pierson, 2004). Thus, changing organizational culture is particularly difficult. And, changing what people do within a stable organizational culture is equally difficult (Ross & Nisbett, 1991).

Organizational culture is made up of the beliefs about the organization, members within the organization, and outsiders who the organization interacts with; sense of organizational mission; definitions of success; social arrangements and interactions; systems of rewards and sanctions; and norms of recruitment and promotion (Allison &

Zelikow, 1999; Goddard, 2003; Wilson, 2000; Woodbury & Gess-Newsome, 2002). Organizational culture is also composed of the historical anecdotes and collective theories of action that help teachers place their own actions within a larger frame of understanding and practice at the school level (Barnet & Hodson, 2001; Bidwell & Yasumoto, 1999). And, while there are many similarities across schools, each school has its own distinctive culture (Burley & Morgan-Flemming, 2008). It is also important to note, that while the individual aspects of the organizational culture (i.e. organizational beliefs) are mediating states, it is the presence in the cultural setting that provides environmental states regarding the school or department culture.

Another aspect of school culture is what Hill (2006) has come to call discourse communities. Discourse communities are the specialized language that develops within a school culture. The language can be technical, supported by research, or colloquial and locally created (Hill, 2006). The same term can also have different meanings across different discourse communities (Coburn & Stein, 2006; Hill, 2006). Bidwell and Yasumoto (1999) have also found that specialized vocabulary contributes to the sense of belonging within a school culture, and exert strong influences on cognition and resulting behavior. Discourse communities are particularly interesting given they shape the environmental states involved in teacher cognition. The decision to call a track, “honors” versus “pre-AP,” versus no label will undoubtedly influence how teachers think about those classes.

A third influence on a teachers practice is that the organizational culture defines in operational terms what the job actually is (Wilson, 2000). While most would recognize the job of teachers is to teach, the school culture puts that in operational terms, and defines what good teaching looks like (Bidwell, 2001). In response to the definition of what good teaching looks like, school culture then fosters internal accountability norms (Elmore, 1995; Shere & Spillane, 2011). Adherence to these norms is, while officially voluntary, imperative for individuals within the culture (Anderson, 1967; March & Simon, 1993). Thus, part of the internal accountability requires individuals adopt as a chronic goal the adherence to the norms of the organization, or risk being ostracized or expelled from the group. The internal accountability system—particularly the internal definition of good teaching—will also dictate the reaction of the school and the individual teachers in the school to both external attempts at reform and external accountability policies (Elmore, 1995; Plank & Condliffe, 2013; Smylie & Evans, 2006).

Linked to the system of internal accountability are also official and unofficial sanctioning systems. Sanctioning systems have been found to influence the degree to which people will act in ethical or unethical ways (Tennbrunsel & Messick, 1999). Sanctioning systems can further influence the degree to which members of an organization are willing to cooperate with each other (Tennbrunsel & Messick, 1999). Unfortunately for schools, sanctioning systems often send either implicit or explicit messages that administrators and policy makers do not trust teachers to effectively carry out their job (Ingersoll, 2003; Sykes, 1983). This fosters a sense of isolation on behalf of teachers and conflict with administrators (Ingersoll, 2003; March & Simon, 1993). As such, the school sanctioning system often supports a culture that flies in the face of the egalitarian and ethical ideals that we hope teachers to have (Anderson, 1967; Ingersoll, 2003).

The role of sanctioning systems as part of the school culture may be even more influential given the incentive pay programs that many districts are adopting. As Tennbrunsel and Messick (1999) point out, the stronger the sanctions, the less likely people are to cooperate in their work environment. It is possible that one of the most detrimental sanctions is the loss of salary. While incentive pay is supposed to recognize the most effective teachers, it also indirectly punishes the least effective teachers by not giving them additional compensation. Thus, teachers may be reluctant to share effective teaching strategies, which would have the potential of decreasing their chances of receiving the incentive pay increase.

Department Subcultures

It is faulty to assume that an organization has only one culture. Instead, there are many subcultures within an organization (Wilson, 2000). While there are multiple ways in which teachers could be grouped into subunits within schools, at the secondary level, teachers are most often grouped by subject matter area (Bidwell, 2001; Hargreaves & Macmillan, 1995; Scott & Cohen, 1995; Siskin & Little, 1995). Siskin and Little (1995) note that by their very nature, departments organized around subject matter highlight the importance of students learning subject matter at the expense of other important organizational goals. This also influences the priorities of the subunits themselves, as they adopt departmental ideologies and pedagogical practices that may or may not be congruent with the goals and culture of the organization as a whole (Bidwell, 2001;

Hargreaves & Macmillan, 1995; March & Simon, 1993; Wilson, 2000). This may partially explain the common refrain of science teachers who suggest that issues of diversity and multiculturalism are issues for the English and social studies teachers.

The degree with which members of one subculture can, for lack of a better term, border cross into other school subcultures differs from school to school, and from department to department within a school. Hargreaves and Macmillan (1995) use the term balkanization to describe the degree with which border crossing occurs. In highly balkanized schools, rarely if ever do teachers belong to multiple subcultures. Highly balkanized departments often resist organizational learning, as there is very little collegiality with others outside the department (Siskin & Little, 1995). Siskin (1995) further notes that science teachers are particularly cut off from other departments in the school.

There are several factors that contribute to the hyper-balkanization of science departments. First, recall the powerful influence that physical space can have on cognition and behavior. When schools are built such that all science classes are in the same wing or hallways, there is little need to exit the science area of the school. The other science teachers are next door. This not only sends an implicit message of geographic self-containment, but may also limit opportunities for casual interactions with other colleagues via walking the hallways. And, because of the spatial and physical requirements of teaching science (i.e. conducting labs, having access to chemical hoods, equipment rooms, etc.) the physical balkanization cannot be overcome by assigning a science teacher to a different room without the possibility of significant cost to the learning experience presented to students.

A second contributing factor leading to high degrees of balkanization of science teachers is the apprenticeship of observation. As there exists a high degree of similarity between the physical space of the school a teacher works at and the one where they conducted the apprenticeship, science teachers may draw on mediating states regarding the collegiality between science teachers. As a student apprentice, they may not have been privy to instances of cross-subject collaboration. The division is further exacerbated by the physical layout of departments in the collegiate setting. Science departments occupy entirely separate buildings.

The third mechanism fostering the balkanization of science departments regards the higher status of science compared to other subjects (Siskin & Little, 1995). Collectively, science teachers carry a great deal of sway within schools, and may have more influence over decision making than teachers of other departments. Thus, we shouldn't expect science teachers to border cross too easily and risk the status they have accrued.

Roles

Part of the school culture is the outward display of legitimacy to other members of the social, political, and economic systems that schools are embedded in (Firestone & Bader, 1991; Metz, 1990). This outward display is likely to include both formal definitions of what the role of teacher is as well as informal cultural definitions of the role teacher and the associated behaviors (Ross & Nisbett, 1991; Wilson, 2000). The framing of a situation within the cultural norms of a school will also dictate behavior of the teacher (Russ & Luna, 2013; Tennbrunsel & Messick, 1999). Thus, the role of teacher is framed very differently in the teachers' lounge, versus the classroom, versus the classroom. The framing is an environmental state, drawing on shared mediating states regarding appropriate role behavior in a given situation.

For example, Saka, Southerland, Kittleson, and Hutner (2013) suggests that if a person does not enact a specific, recognized identity, their actions may be dismissed by members of their community. Specifically, they found that in one school, the behavior and pedagogy for the role of science teacher was clearly defined by members of the community, and it was very difficult to choose not to act in such a way. When a reform minded first year science teacher entered the school, he struggled both in his teaching and with his identity as a science teacher.

Public Policy

The history of public schooling in America is the progressive increase in centralization of public schools, from locally determined practices to large federal involvement in local school decision making processes (Cheek & Quiriconi, 2011; Kahle & Woodruff, 2011). Most recently, the federal *No Child Left Behind* act has expanded the federal influence on public schools and continued the centralization process (Schneider & Kessler, 2007). Policy, including both legislation and executive agency code, is a formal statement intended to influence the practice of teachers (DeBoer, 2011; Halverson & Clifford, 2006). Thus, I review the literature on policy in the section on social influences as policy is a formal attempt by policy makers to influence the cognition and practice of teachers.

One of the strongest policy influences on teacher actions is the current wave of high stakes accountability policy, including standards documents that prescribe the content students need to learn and high stakes tests that measure student learning of the standards. Responding to the claim of the National Commission on Excellence in Education (1983) that schools were offering a “smorgasbord” of educational options, states sought to more formally delineate the content students were required to learn in schools. Teachers no longer hold the responsibility of what concepts to teach within their classrooms, they are spelled out for them via standards documents. Furthermore, contained within standards are epistemological and ontological assumptions about the nature of subject matter. As many states, such as Texas, have begun to adapt standards that draw upon traditional notions of the nature of science (Schoenfeld, 2004), a powerful environmental state reflecting traditional approaches to the nature of science is activated in teachers. Thus, cognition around standards is influenced by traditional notions of the nature of science.

Anderson (2012) remarks that the testing aspect of accountability policy has been equally impactful upon science teachers. Several studies have shown that the impact of standardized tests reduces both the scope of topics to be covered and the pedagogical approaches teachers use in their classes (Anderson, 2012; Aydeniz & Southerland, 2012; Burley & Morgan-Flemming, 2008; Datnow, 2006; Figlio & Getzler, 2002; McGinnis, Parker, & Graeber, 2004; Southerland & Abrams, 2008; Taylor, Jones, Broadwell, &

Oppewall, 2008**).** In schools governed via high-stakes accountability policy, “teachers are pressured to focus on using traditional instructional and assessment practices that have been effective in improving students’ achievement scores” (Aydeniz & Southerland, 2012). Unfortunately, these practices push out the reform oriented approaches advocated by teacher education programs.

Smith (2000) points out an additional facet of the current testing regime that has largely gone unnoticed in research on teachers. The high-stakes test becomes such a powerful policy influence on teachers and schools that the majority, if not all, instructional decisions are made against the specter of the standardized tests. School and district administrators “actively discouraged [teachers] from teaching anything that did not help students decode standardized test questions” (Anderson, 2012, p. 118). Smith (2000) found that when schools become so focused on tests, they lack any contextual information regarding what to teach students *after* the administration of the test. In other words, the tests are such powerful environmental cues on cognition, that when the influence is removed, teachers lack any contextual information regarding what they should be teaching or how to go about teaching it.

The Principal

Historically, there has been debate on the level of influence that principals and other school administrators have over what occurs in classrooms within their school. Some scholars have treated them as mostly middle management (Wilson, 2000), while others suggest principals are particularly powerful actors in the school (Ingersoll & Merrill, 2011).There appears to be an emerging consensus, however, that principals have become the key to effectively implementing reform and responding in constructive ways to accountability mechanisms (Firestone & Riehl, 2005; Spillane, Diamond, Burch, Hallett, Jita, & Zoltners, 2002). Because of this, principals are now often framed as instructional leaders, and with their new role definition comes increased ability to make organizational decisions related to the teaching and learning of students (Firestone & Riehl, 2005).

Evaluating teachers. One of the most powerful tools for influencing a teachers practice in the classroom available to principals, and other school and district administrators is the ability to evaluate teachers. Evaluation of teachers is often described as constraint driven management where, teachers are evaluated not against organizational goals; instead, they are evaluated against the degree to which they comply with directives from school and district level administration (Allison & Zelikow, 1999; Firestone & Bader, 1991; Ingersoll, 2003; Wilson, 2000). Sanctions are carried out against teachers not for failure to be effective, but for failure to follow both formal school policies and procedures and informal school norms. This is consistent with the notion that highly-qualified teachers are hired to signal legitimacy outward, but expected to table the use of such expertise internally by following pedagogical and curricular mandates from above (Firestone & Bader, 1991; Wilson, 2000).

As with students, both formative and summative evaluations can be used with teachers. Formative assessments could be used for the improvement of practice. Yet, set against the background of constraint driven evaluation, formative assessments have often been dropped at the expense of only summative assessments of teachers (Halverson &

Clifford, 2006; Ingersoll, 2003). Given the risk aversion of individuals and the directives for compliance, many teachers come to fear the presence of an administrator in their classroom (Kahneman, 2011; Ingersoll, 2003). Summative assessments of teachers are often used to weed out bad teachers, defined as those who fail to comply with directives. Summative assessments of teachers also undermine most attempts to improve instructional practices of teachers as administrators do not identify reform oriented teaching as good teaching (Halverson & Clifford, 2006; Ingersoll, 2003).

This has coincided with the tendency across the U.S. toward summative assessments of students as well (Aydeniz & Southerland, 2012). Thus, administration has an additional tool at its disposal in evaluating teachers: student test scores. The use of student test scores as part of the constraint driven evaluation of teachers has lead Webb (2005) to use the term "data surveillance." In the data surveillance technique, little authority of the educational processes is given to teachers, yet they are still the ones held accountable for the desired outcomes (Anderson, 1967; Bouvens & Zouridis, 2002; Webb, 2005). The logic behind data surveillance is that if student test scores are bad, it must be due to a lack of compliance with administrative directives, particularly those of a curricular nature.

Tracking

"It is the rare school that has no mechanism for sorting students into groups that appear to be alike in ways that make teaching them seem easier" (Oakes, 1985, p. 3). As mentioned earlier, the processes of categorization, at the cognitive level, leads to treating all members of the category in a similar manner (Marcus, 2000). Tracking, at its basic level then, is a system of categorizing students, such that the efficiency of the educational service is increased and partially ameliorates the lack of resources at a teacher's disposal (Lipsky, 2010; March & Simon, 1993). Via a process of categorization, those traits that members of the category have in common will be highlighted as environmental states, and differences will be suppressed. Thus, teachers focus on the commonalities of students in the category, and teach accordingly.

Tracking, and categorization, however, have profound effects on the individuals whom are so labeled. First, being tracked will undoubtedly influence the ways teachers talk and think about individual students within the track (Coburn & Stein, 2006). However, teachers are often not the only professional in public service that a student and their family may interact with. Thus, the label associated with the track may send a signal to others on appropriate interactions with students. Even within the school system, a student has multiple teachers, yet their track and the label associated with the track will follow the student between schools. Thus, before ever meeting a student, a teacher already knows a great deal, as information about the student has been supplied via the environmental state of the track label.

Within the current era of educational policy, tracking has taken on a new dimension. Historically, tracking has manifested itself in assignment of students to college preparation or vocational tracks (Oakes, 1985). Yet, the pressure on public schools to increase student test scores had led to a new form of tracking where schools adopt triaging strategies for helping students (Anagnostopoulos, 2003; Booher-Jennings, 2005; De Vise, 2007; Lipsky, 2010). In light of a limited budget of time and money, resources must be rationed to those most likely to benefit from small increases in the attention of teachers (Lipsky, 2010). Schools that operate via educational triage will identify those students on the cusp of passing a high stakes test and target instructional resources at them (Booher-Jennings, 2005; De Vise, 2007). Thus, students with very high test scores or very low test scores are ignored because the return on investment of limited resources is small, at best.

Time

Time is by far the most valuable resource at the disposal of any organization (Cuban, 2009; Lipsky, 2010; Lortie, 2002; Pressman & Wildavsky, 1984; Smith, 2000). Time is also the resource that is most limited for teachers. In studying organizations, Pressman and Wildavsky (1984) claim that:

> If you want to know what matters most to an organization, chart the activities on which its members spend their precious allotment of hours. The allocation of time deserves, though it does not receive, the same attention that we give to the allocation of financial resources (p. 121).

Smith (2000) and Kennedy (2005) did just that, and both conclude that sustained time for the core task of teaching and learning is rare within schools. Smith (2000) found that over twenty percent of the school calendar was interrupted by parties other than school personnel, via things like special assemblies or weather delays. Kennedy (2005) also notes that within individual class periods, there is a high likelihood of interruption by other employees of the school. Both remark on the ramifications of the proliferation of state mandated tests near the end of the year, along with locally developed mandatory assessments to promote data based decision making.

Teachers are often excluded from the decision making process regarding classroom interruptions. Their role is to comply with the time demands placed upon them from above. Teachers also have very little say in the way their time is allocated throughout the day (Ingersoll, 2003). Teachers do not get to choose when to have their planning period, or the circumstances under which they collaborate with others. As data based decision making has gained prominence, administrators have begun to infringe upon teachers free time during and after the school day as well with data analysis tasks. As Kennedy (2005) finds, this lack of temporal authority restricts the ability of teachers to negotiate meaning between the various demands placed on them and their students.

"Ironically, schools are places where sustained thought is rare" (Kennedy, 2005, p. 3). This statement holds true for students and teachers. As teachers face a multitude of demands for their time each day, the time they can dedicate to one issue is seriously compromised. During their planning time, not only are teachers planning lessons, but they must also call parents, grade assignments, complete paperwork and forms, and attend a variety of meetings (Ingersoll, 2003; Kennedy, 2010). Furthermore, teachers often confront multiple reform efforts at once, again restricting the time they might devote to thinking about a single effort at reform and the implications for their classroom

Another manifestation of this the lack of temporal resources regards teaching loads. Kennedy (2005) and Smith (2000) both mention that on international comparisons, the ratio of planning time to teaching time is strikingly low. U.S. teachers are given much less time to plan than their international peers. This restricts the ability of teachers to think deeply about their students and subject matter and their ability to draw on nuanced pedagogical knowledge to plan and implement reform based lessons. This problem is exacerbated when teachers are assigned multiple preparations. Thus, the limited free time a teacher has must be shared amongst a number of classes, and multiple different teaching assignments.

RESEARCH ON TEACHERS GOAL STATES

In this section, I review the literature on the goals of teachers. Given that the distinction between cognitive policies and goals has not been made in previous research on teachers, I do not use the term in this section. However, prior to reviewing the literature, most of what is reviewed focuses on broader goal representations, and as such, would likely be classified as cognitive policies, located at higher levels of a teacher's goal hierarchy.

Despite the popularity of cognitive approaches to the study of teachers, considerably less research has been conducted on goal representations as compared to mediating states and environmental states. This may be due to the tendency within educational research that treats goals as part of the mediating states (i.e. beliefs or knowledge) of teachers, as opposed to separate representational elements. For example, Belo and colleagues (2014) found that "the beliefs of physics teachers about the goals of education in general and their domain-specific beliefs about the goals of physics education (i.e. curriculum emphases) formed an interrelated belief system" (p. 97). Along with Belo and colleagues (2014) many others treat goals as a subset of beliefs

(Friedrichsen, Van Driel, & Abell, 2011; Webel & Platt, 2015). Others conflate goals with knowledge, often by suggesting that teachers' goals for their classrooms are embedded within the development of PCK (Gess-Newsome, 1999b; Magnusson, et al., 1999).

Goals for the Classroom

There is a small, but important body of literature on the goals teachers have for their teaching, their students, and their classroom. Of broad agreement is that in order to realize the vision of science teaching and learning put forth in the reform documents (AAAS, 1990; NRC, 1996; 2000; 2012), "teachers need to be clear about what they are trying to accomplish" (Darling-Hammond, et al., 2005, p. 193; also, Bartos & Lederman, 2014; Belo, et al., 2014; Crawford, 2007). Crawford (2007) suggests a link between the goal of teaching through inquiry and teachers engaging their students in scientific inquiry. Bartos and Lederman (2014) add that without helping preservice teachers to prioritize teaching the nature of science, there is little reason to expect they will explicitly address the nature of science upon entering the classroom.

Common across the few studies that investigate the goals of science teachers is the proposition that teachers hold multiple goals governing their classroom practice (Belo, et al., 2014; Gess-Newsome, 1999b; Kennedy, 2005; 2006a; 2006b; Magnusson, Krajcik & Borko, 1999; Thomson & Palermo, 2014). In a particularly influential book chapter, Magnusson, Krajcik and Borko (1999) draw upon Grossman's (1990) idea of orientations as part of PCK to suggest that there are nine distinct orientations to teaching science, each of which is associated with a different goal for teaching and learning. For example, teachers with didactic orientations have the goal to “transmit the facts of science” (Magnusson, et al., 1999, p. 100), while a teachers with a discovery orientation holds the goal to “provide opportunities for students on their own to discover targeted science concepts” (Magnusson, et al., 1999, p. 100). Magnusson and colleagues further posit that different orientations and their associated goals lead to divergent practice in science teachers. Differences in classroom practice resulting from differing goals is congruent with the predictions of the model of cognition put forth earlier.

However, there are some shortcomings with the Magnusson, Krajcik & Borko (1999) chapter that may contribute to the lack of research on teacher’s goals (Friedrichsen, et al., 2011). One conceptual issue with the Magnusson and colleagues (1999) framework not identified in the review by Friedrichsen and colleagues (2011), and as such a trapping they also fall into, is the tendency to conflate the beliefs of science teachers with their goals. In their critique of previous work on science teacher orientations, Friedrichsen and colleagues (2011) suggest one of the difficulties with studying orientations is that “beliefs about purposes and goals for teaching science are often implicit, unobservable and difficult” (p. 370). Like many other studies, this line of work suggests that beliefs and goals are interchangeable mental constructs.

Kennedy (2005) describes a taxonomy of 6 intentions that shape teachers practice. Of these, four are goals for the classroom: “covering content, fostering student learning, maintaining lesson momentum, and fostering student willingness to participate” (p. 43). Interestingly, Kennedy (2005) makes it a point to call these intentions, as opposed to goals, because “only a fraction of the things teachers were interested in were expressed as goals. Another fraction referred to things teachers wanted to *avoid* [italics in original]" (p. 41). In this definition, goals are end states that teachers want to bring about, subsumed under a broader construct of intentions. However, within the theory of cognition laid out above, both ends that a teacher wants to bring about (i.e. student learning) and situations that a teacher wants to avoid (i.e. classroom interruptions) are goal representations, as they reflect the desired status of the future environment.

Goals of Teachers as Members of the School

While much of the previous work on teachers pedagogical decision making has treated the teachers classroom decisions as independent from other organizational influences, there is a growing recognition that "teacher's classroom decisions about their work are nested within, and highly dependent upon, the larger process of conceiving, planning, and implementing the educational goals of the school, over which most teachers have little influence" (Ingersoll, 2003, p. 154). In other words, teachers make decisions regarding their teaching practice with respect to the goals of the school of which they are a part. One of the important characteristics of accountability policy has been to delineate the goals of the school system in unambiguous terms: students passing standardized tests (Anagostopoulos, 2003; Davis, Petish, & Smithey, 2006; Loeb & McEwan, 2006).

With respect to science teachers, "because increasing test scores become the central purpose [i.e. goal] of school systems" (Aydeniz & Southerland, 2012, p. 105), curricular decisions are made with respect to this important, powerful, and ever-present goal of the school system. Often, science teachers view the approaches advocated by the reform documents (AAAS, 1990; NRC, 1996; 2000; 2012) as diametrically opposed to the goals of the school system embodied in accountability policy (Anderson, 2012; Aydeniz & Southerland, 2012; Donnelly & Sadler, 2009; Settlage & Meadows, 2002; Saka, Southerland, & Brooks, 2009; Shaver, Cuevas, Lee, & Avalos, 2007; Taylor, Jones, Broadwell & Oppewall, 2008). In other words, teachers express a goal conflict between the goals embodied in the reform documents and the goals embodied in high stakes testing policy. Thus, when teachers are making curricular decisions driven by the goal of having students pass standardized tests, they are likely not pursuing goals related to reform oriented science teaching.

Finally, teachers are often driven by chronic goals that govern their response to the context of the school (Kahneman, 2011; Kennedy, 2005). One of the last two of Kennedy's (2005) taxonomy of intentions is promoting a civil classroom environment and effective classroom management. As Habermann (1991) remarks, effectively managed classes are valued by all members of the school community, including other teachers, parents and administrators. In this case, there is goal congruence between the goals of the teacher and the goals of other members of the school, leading to a higher likelihood that effort will be directed toward attainment of such a goal.

Another way that chronic goals can manifest themselves is via loss aversion—particularly with regards to one's employment status (Kahneman, 2011). This goal is not to achieve a possible future, but to prevent an undesirable possible future (i.e. losing your job). Under the influence of loss aversion, a teacher will acquiesce to the goals of those who are responsible for their job status, such as a principal or department head. This results in teachers increased willingness to adopt, often unquestioned, the curricular guidance of the school and district.

SUMMARY

In this chapter, I have presented a theory of cognition suggesting that cognitive process act upon three representations: mediating states, environmental states, and goal states. The role of mediating states—particularly beliefs and knowledge—and the role of environments have been popular avenues of research on science teachers for some time. There is a large body of research documenting the relationship between beliefs, knowledge, and practice. There exists an equally voluminous body of work on the influence of the physical and social context of schools on teachers practice. Finally, there is much work to be done examining the goal representations of science teachers, and the relationship between goals and classroom practice. I turn toward that end in the next chapter.

Chapter 3: Methods and Methodology

This chapter details the methods, and underlying methodology, that was used to examine the content and development of the goal systems of preservice teachers as they reflect on and plan for their first year of teaching while completing the student teaching semester.

The remainder of this chapter will be organized as follows: first I detail the theoretical framework guiding the inquiry into student teachers. I also discuss the appropriateness of qualitative methods, and how the theoretical framework shapes the use of such methods. Second, I more formally introduce the research questions guiding this study. Third, I briefly describe the intended setting and participants. Fourth, I describe the methods to be used for data collection and analysis. Last, I describe the researcher as instrument, and detail my positionality vis-a-vis this research project.

THEORETICAL FRAMEWORK

The overarching theoretical framework guiding this study is the model of cognition laid out by Markman and Dietrich (2000a; 2000b; Dietrich & Markman, 2003). As presented in Chapter 2, cognition requires three representational elements—mediating states, environmental states, and goal states. Further detailed in Chapter 2, researchers examining why science teachers do what they do in the classroom have explored in great depth the mediating states of teachers, the physical and social environment that teachers work in, and how practice plays out in the classroom.

However, little is known about the goal systems of teachers. As defined in Chapter 2, goals are mental representations that specify a state of the world yet to be achieved (Aarts & Elliott, 2012; Aarts & Dijksterhuis, 2000; Altmann & Trafton, 2002; Carver & Scheier, 1998; Fujita & MacGregor, 2012; Markman, Brendl & Kim, 2007; Markman, Maddox, & Baldwin, 2005; Shah & Kruglanski, 2003; Sheeran & Webb, 2012). Furthermore, recall that goal representations can be representations of actions to take (i.e. use scientific argumentation) or outcomes to pursue (i.e. students learn about climate change).

Goal Hierarchies

Within the literature, there is much variability in the level of abstraction that goals can take. Some use goals to refer to quite specific outcomes (i.e. the goal to grade students lab reports) while others use goals more broadly (i.e. a teacher has the goal to teach through inquiry). This study specifies goals as “representational structures connected to representations of the means that support goal satisfaction” (Markman, et al., 2007, p. 680). In other words, a goal typically has a one-to-one correspondence between action and goal satisfaction, whereas a cognitive policy is a more abstract representation. As an example, the goal update a class’ grades can be satisfied via the singular action of a teacher entering the most recent assignments into their gradebook. However, the cognitive policy of teaching through inquiry requires multiple steps at multiple points in time to achieve such an outcome.

In response to variability of abstraction in goal representations, many theorists have adopted hierarchical models of goal pursuit (Boekaerts, de Koning, & Vedder, 2006; Carver & Scheier, 1998; Gollwitzer & Moskowitz, 1996; Locke & Latham, 1990; Markman & Brendl, 2005; Moskowitz, 2012; Shah & Kruglanski, 2007). At the lowest level of the goal hierarchy are concrete goals that are typically quite specific in both scope and action. At higher levels of the hierarchy are more abstract goals that are broad in both scope and in the required actions to bring these to fruition. The degree to which people remain committed to a goal also increases at higher levels of the hierarchy. In order to distinguish amongst levels, in this study, goals are used to refer to the lowest level of the goal hierarchy. Cognitive policies, as introduced in Chapter 2, are used to refer to representations higher on the goal hierarchy.

Because cognitive policies lack specificity in the means required to satisfy them, cognitive policies are often linked to more concrete goals at lower levels of the hierarchy (Carver & Scheier, 1998; Fujita & MacGregor 2012; Locke & Latham, 1990). The realization of a cognitive policy often requires the satisfaction of multiple, lower level goals. It is also possible that the same goal must be pursued multiple times, in slightly different contexts, in order to satisfy a cognitive policy. As an example, a teacher with the cognitive policy to teach via inquiry will need to satisfy more specific goals, often more than once, related to the day to day curriculum in order to realize cognitive policy of inquiry based instruction. The relationship between the levels of the hierarchy is such that multiple goals can often be employed in service of a singular cognitive policy—there is not a one-to-one correspondence between levels of the hierarchy. This notion is important, because situational factors can influence which specific goals will be employed in service to a given cognitive policy in a given situation. Only those goals that are contextually appropriate will become active, and guide progress toward the cognitive policy. This also means that if there are no contextually appropriate goals for a given situation, it is not possible for one to progress toward satisfaction of overarching cognitive policies, despite a strongly expressed commitment.

There is no agreed upon number of levels to a goal hierarchy. For example, Markman and Brendl (2005) distinguish between two levels: cognitive policies and goals. Carver and Scheier (1998) suggest there are at least five levels, with sequences at the lowest level, followed by mid-level programs, and principles at the top. I draw upon both notions to describe the hierarchy. Specifically, I suggest that there are goal level representations, which are at the bottom of the hierarchy and direct behavior via a one-to-one correspondence between goal and action. Levels above this, I refer to as cognitive policies. At the same time, I allow for a hierarchy within the cognitive policies, such that a higher-level cognitive policy may be supported by lower level cognitive policies. For example, a teacher can have the cognitive policy "to be a good teacher," which is supported by lower level cognitive policies such as "teach through inquiry" and "use culturally responsive pedagogy." Figure 3.1 shows a graphical representation of the hierarchical organization of goals and cognitive policies.

For those who subscribe to the theoretical approach of a goal hierarchy, behavior is the result of lower level goals currently active in cognition. At the same time, these goals are often active because a cognitive policy is also active, priming a contextually appropriate lower level goal. What this means is that "people's justifications of their behavior will tend to focus on end states that are more abstract than the ones that drive behavior" (Markman & Brendl, 2005, p. 196). In other words, when asking about past, present, and future motivation for acting in a certain way, people often report their cognitive policies. This distinction is important for a study that uses interview techniques to understand the cognition of individuals, including teachers. A study examining the goal directed behavior of teachers is likely unable to gain information on the lowest level of the goal hierarchy. Instead, research on goal systems is limited to cognitive policies that guide the activation of the lowest level goals.

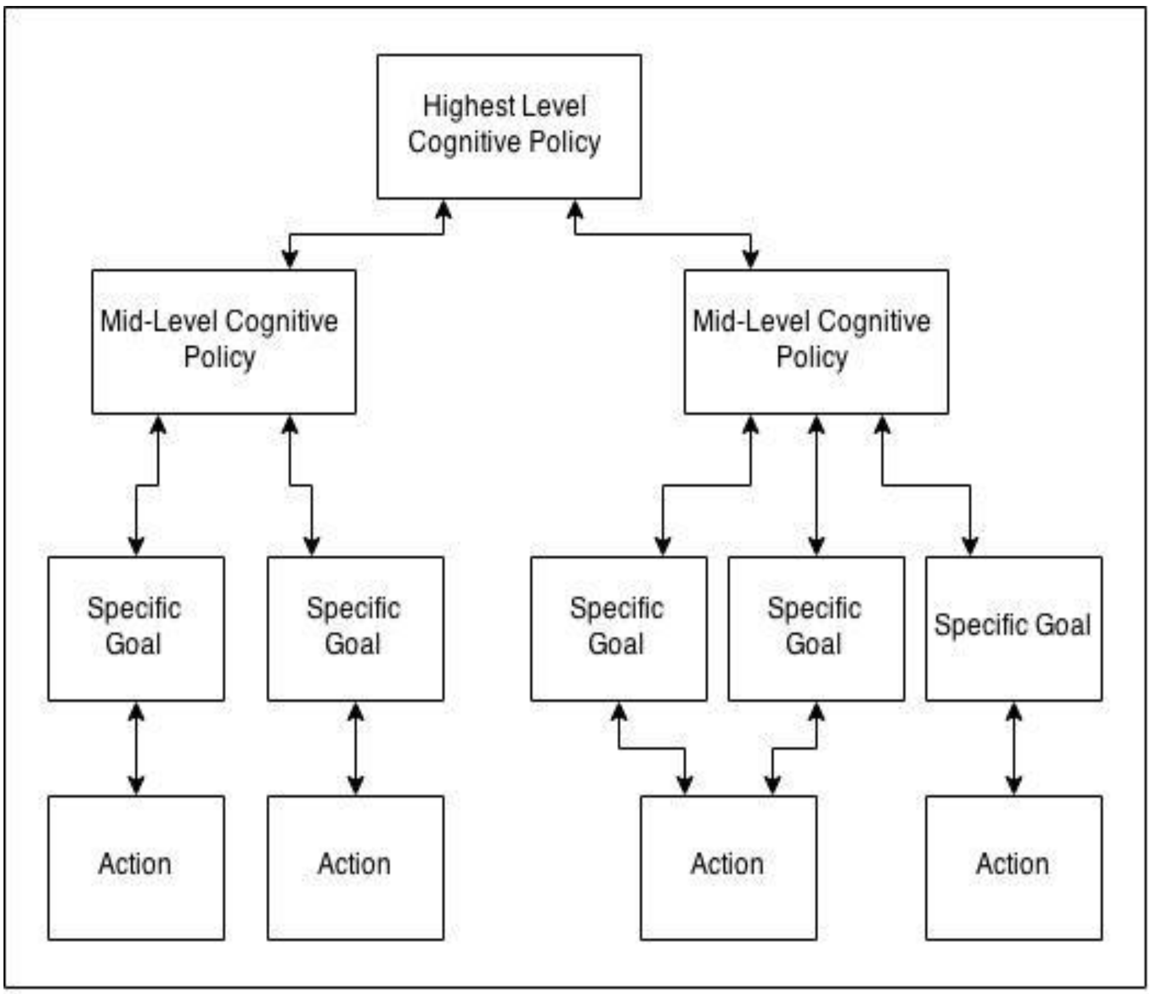

Figure 3.1: A Hierarchical Model of Goals

Goal Systems

Recent research on the influence of goals on cognition and behavior has added to the notion of the goal hierarchy via the suggestion that at any given time, people hold multiple goals and cognitive policies they might pursue (Fishbach, Dhar & Zhang, 2006; Moskowitz, 2012; Shah & Kruglanski, 2007; Stroebe, Konningsbruggen, Papies & Aarts, 2013). Thus, goals and cognitive policies do not exist in isolation, but instead exist in a more global goal system[5]. Within a goal system, it is possible for goals to be reinforcing, such that progress towards the satisfaction of one goal results in progress toward a second goal (Moskowitz, 2012). For example, grading papers in service of the goal to provide students with timely feedback may also serve the goal of keeping an accurate gradebook.

More often than not, however, goals are not so harmonious. Instead, goals are often either in competition or conflict. This distinction—goal competition versus goal conflict—is more than a semantic one, and as such, I expand upon the two notions below. The notion of goal competition starts by recognizing that like all representations, there is limited energy within the goal system, such that not all goals can be active at the same time (Markman, et al., 2007). Furthermore, resource and time constraints place limits on the number of goals that one can pursue at once (Carver & Scheier, 1998; Moskowitz, 2012). Thus, goals are constantly in a state of competition within the goal system. They compete in the sense that the activation energy is limited, and each goal "seeks" to gain enough energy to engage the motivational system and produce behavior by the individual

[5] To avoid confusion, in the remainder of this subsection, I use the term "goal" more generally, referring to any and all levels of the goal hierarchy. This is congruent with the work on goal systems, where researchers rarely specify the level of a goal hierarchy when examining the interplay of multiple goals.

(Laran & Janiszewski, 2009; Shah, Friedman, & Kruglanski, 2002; Sheeran & Webb, 2012). Often, goals in competition are thought to create an "approach-approach" problem for individuals (Shah & Kruglanski, 2007; Sheeran & Webb, 2012), where both goals are desirable, yet only one goal can be pursued at a time. For example, a teacher may have simultaneous goals to lesson plan for their next day's classes and to grade papers during the planning period. It is not possible to do both at the same time.

While goal competition is often the result of an approach-approach problem, goal conflict exists when progress towards one goal leads to movement away from another goal (Gollwitzer & Moskowitz, 1996; Fishbach & Dhar, 2005; Fishbach & Shah, 2006; Fishbach, Zhang, & Koo, 2009). Similar to goal competition, goals in conflict also compete for activation of the motivational system. A classic example is from research on people who are on a diet. For these people, the goal system is "dominated by a conflict between two incompatible…goals, namely the goal of eating enjoyment and the goal of weight control" (Stroebe, Mensink, Aarts, Schut, & Kruglanski, 2008, p. 28). Thus, it is possible to explain attitude-behavior inconsistency by appealing to the notion of goal conflict. In other words, actions that appear incongruent with a previously stated goal may be taking place because a conflicting goal is currently active.

When goals are in competition or conflict, there must be a resolution of some kind that allows for action on behalf of the individual. "All things being equal, relative goal activation drives behavior" (Laran & Janiszewski, 2009, p. 969). The most active goal will be responsible for behavior (Aarts & Dijksterhuis, 2000; Altmann & Trafton, 2002). Often times, this results from situational cues that indicate a goal is both appropriate to pursue in a given situation and action in pursuit of the goal is likely to be successful (DeShon, Kozlowski, Schmidt, Milner, & Wiechmann, 2004; Gollwitzer & Moskowitz, 1996). It is also possible for a person to be strongly committed to a goal, such that they pursue goal satisfaction by maintaining a high level of activation without regard for the ability of the environment to support such pursuit (DeShon, et al., 2004). Goal competition and conflict can also be resolved via inhibitory processes, such that the activation of one goal simultaneously induces an inhibition for another goal, thereby reducing the likelihood that a secondary goal will meet the activation threshold necessary to engage the motivational system (Shah, Friedman, & Kruglanski, 2002).

There are additional ways in which goal competition and conflict are resolved without requiring differential levels of activation. First, concrete goals are often easier to pursue than more abstract goals (Fishbach, Zhang, & Koo, 2009; Locke & Latham, 1990). In other words, for two goals at different levels on a goal hierarchy, the goal lower on the hierarchy is more likely to guide action. Fishbach, Dhar, and Zhang (2006) also suggest that people often balance between multiple goals, particularly when they reflect upon their progress toward goal satisfaction. For example, if a teacher has spent the first half of their planning period creating the next day's lesson, they may balance their goal pursuit and switch to grading papers for the second half of the planning period. A third way that goal competition and conflict is often resolved is via the use of feedback. Fishbach and colleagues (Finkelstein & Fishbach, 2012; Fishbach, Eyal, & Finkelstein (2010) suggest that effective use of feedback can increase commitment to and subsequent pursuit of a goal. For two goals in competition, if there is ample feedback available for one and not the other, the goal with feedback cues is more likely to be pursued. Finally, it is possible that goal competition, and more importantly, goal conflict are resolved by disengagement from a goal (Gollwitzer & Moskowitz, 1996).

A Hierarchical Model of Goal Systems

Taking the previous discussion into account, this study is framed via a theoretical commitment to the role of goal representations as fundamental elements for cognition and action. Goals exist in a system of goal hierarchies. Goals at the lower level of the hierarchy are quite specific. At higher levels, cognitive policies are often more abstract in their construal. Often times, multiple goals can exist in service to a cognitive policy. Thus, there are multiple hierarchical goal systems in memory at any given time. Only those goals and cognitive policies that are active can influence cognition and action. Goals hierarchies are often in competition where multiple goals may be contextually appropriate, but only one can be pursued at a given time. Finally, goals in competition and conflict must be resolved in some way, often via a disengagement from one or more goals.

RESEARCH QUESTIONS

Given the above discussion, we can restate the purpose of the study mentioned in the first chapter in more specific terms. The more formal research question driving this study is: *what are the cognitive policies comprising the goal systems of student teachers of science as they reflect on and plan for their first year of teaching?* Furthermore, there are two, related subordinate questions that aid in answering the overarching question:

1. Do the goal systems of student teachers change over the course of the student teaching semester, and if so, what are those changes?
2. Do student teachers experience conflict between cognitive policies within and across goal systems, and if so, what are those changes?

METHODOLOGY

Qualitative approaches are particularly appropriate when research seeks to uncover the processes connecting varying phenomena (Denzin & Lincoln, 1994; Miles, Huberman, & Saldana, 2014). Qualitative approaches are also fruitful when research explores the human condition—how people come to understand and act upon their world (Creswell, 2000; Denzin & Lincoln, 1994; Guba & Lincoln, 1994; Merriam, 2009; Patton, 2002). This study seeks to uncover the goal systems of student teachers as a key, and unexplored, facet of teacher cognition. This is in line with the second rationale mentioned above, and as such, qualitative methods are most appropriate for this study.

Ontological and Epistemological Assumptions

From an ontological standpoint, I approach qualitative research from a postpositivist stance best summarized by Miles and colleagues (2014), who maintain that:

> Social phenomena exist not only in the mind but also in the world—and that some reasonably stable relationships can be found among the idiosyncratic messiness of life. There are regularities and sequences that link together phenomena. From these patterns, we can derive the constructs that underlie individual and social life (p. 7).

I suggest that this is a modified version of postpositivism as it traditionally has been treated in educational research. Guba and Lincoln (1994) concur with the above statement regarding the postpositivist stance, while critiquing this stance by claiming the primary aim of postpostivist research is for "explanation, ultimately enabling the prediction and control of phenomena, whether physical or human" (p. 113).

While postpositivist approaches within the natural sciences may derive from the triad of explanation, prediction, and control, social scientists such as Miles and colleagues (2014) do not advocate for research that leads to the control of humans. Instead, they, like I, argue that a postpostivist stance on qualitative inquiry suggests there are regularities in the relationship between phenomena, and qualitative research can uncover those regularities. Within research on teachers, I take this to mean that there are regularities across schools and teachers that influence the way teachers teach, and ultimately student learning. A more nuanced understanding of these regularities can help teacher educators better equip preservice teachers to confront those regularities such that student learning improves.

To be upfront, I make normative claims regarding what good teaching looks like, based upon bodies of evidence contained in reports such as *Science for All Americans* (AAAS, 1990), *The National Science Education Standards* (NRC, 1996), and *The Framework for K-12 Science Education* (NRC, 2012). As a postpositivist, then, I am claiming that there are regularities that influence the degree to which teachers implement reform oriented curricula leading toward scientific literacy.

It is important to note other ontological traditions within educational research also make normative commitments. Again drawing on notions put forth by Guba and Lincoln (1994) critical traditions in educational research pursue an agenda that seeks to critique and transform current social structures, and that "the criteria for progress is that over time, restitution and emancipation should occur and persist" (p. 113). The normative standard for critical traditions is transformation and emancipation. Thus, good teaching, good teacher education, and good research is defined against a standard of emancipation. On this view, normative commitments are not unique to one set of ontological assumptions.

The Epistemological Question.

As put forth by Guba and Lincoln (1994), the epistemological question asks about the relationship between the researcher and the object of inquiry. Traditional postpositivist stances, suggest Guba and Lincoln (1994), approach the epistemological question from a dualist perspective, where the researcher is to remain separate from the phenomena under study. This allows for the manipulation of variables in controlled settings. However, qualitative researchers have expanded upon this strictly dualist perspective to allow for more naturalistic inquiry into social phenomena.

First, the research community recognizes the dichotomy of controlled experiments versus naturalistic inquiry is much more "a continuum with completely open field work on one end and completely controlled laboratory control on the other end…with varying degrees of researcher control and manipulation between these end points" (Patton, 2002, p. 42). Thus, the epistemological question, as framed by Guba and Lincoln (1994) is one of the degree to which a researcher does or does not manipulate the settings they are studying.

Patton (2002) continues that that the mere presence of a researcher, asking questions and interviewing participants reduces the degree to which events unfold naturally. As most teachers do not sit down for in-depth interviews with a researcher on a daily basis, the interview itself is a manipulation of the daily schedule of the interviewee. The researcher has, to a small degree, exerted control over the use of time by those with whom they engage in an interview.

Recognizing these critiques by Patton (2002), the answer to the epistemological question underlying this study is on the naturalistic end of the continuum. Again drawing on Patton (2002), this study is naturalistic in that "the research takes place in real-world settings and the researcher does not attempt to manipulate the phenomena of interest (p. 39). However, I also recognize that my presence and interactions with participants influence the way events unfold.

The Generalizability Question

"Although there may be disclaimers from some research practitioners, all researchers strive for some degree of generalizability for their results" (Shulman, 1997, p. 13). Statements such as this are likely to be quite problematic for many educational researchers. Typically, generalizability is associated with quantitative methods, where statistical significance allows one to generalize from a sample to the larger population (Patton, 2002; Payne & Williams, 2005; Willis, 2007). As such, this has led social scientists, including those in education, to endorse, either explicitly or implicitly, a false dichotomy of generalization, in that all quantitative research seeks to generalize and in response, qualitative research does not (Payne & Williams, 2005).

In order to make generalizations, one must first answer two foundational questions: (1) to what extent will the interpretation of the results be appropriate and meaningful and (2) to what extent will the results be free from error" (Gronlund, 1998, p. 199)? The first question asks about the validity of quantitative techniques, while the second asks about their reliability. Within qualitative research, however, these terms have been replaced by notions of trustworthiness and credibility (Creswell, 2003; Merriam, 2009; Patton, 2002). In this view, questions to be asked revolve around the appropriateness of the study design, the ethics of the researcher, and the plausibility of results, given the data.

At the same time, some qualitative researchers do not fully reject the point that Shulman (1997) was making. For these researchers, they do want there to be some transferability of results across settings (Merriam, 2009; Willis, 2007). Without some degree of transferability, the results of a research project are idiosyncratic at best. In this view, the responsibility for generalizations rests not with the author of a study, but with the consumer (Willis, 2007).

This brings me to the answer to the generalizability question that informs this study. The goal is to conduct research in such a way that it is informative to other teacher educators as they reflect and refine their practice. Drawing from postpositivist assumptions, I believe that the overlap of multiple participants allows us to identify patters in the cognition of student teachers. Furthermore, this adds to the cannon, helping the field as a whole identify patterns in the cognition of teachers more generally.

Theoretical Underpinnings of Data Collection

There is an intimate relationship between the theoretical foundation and the data to be collected. First, the theoretical foundation is used to define what counts as possible sources of data (Kuhn, 1996). Second, the theoretical foundation implicates the instruments available to collect said data (Kuhn, 1996). For qualitative research, the instrument used for data collection and analysis is the researcher themselves. A more in depth discussion of the researcher as instrument will be put forth in the section titled "Researcher as Instrument."

As for the appropriate data sources for this project, the theoretical commitments identify interviews, observations, and artifacts as fruitful sources.

On the Role of Interviews

Interviewing is a particularly powerful form of qualitative data collection, in that it allows the researcher access to cognitive components of participants they would otherwise not have access to (Creswell, 2003; Merriam, 2009; Rubin & Rubin, 2005). An interview can provide the researcher with direct access to mediating states and goal systems of teachers.

Within educational research, there is often a fear of social desirability bias, where interviewees provide researchers with the answer they want to hear (Craig, 2006; Deemer, 2004; Gill & Hoffman, 2009; Fang, 1996; Kagan, 1990). The social desirability bias is often employed to explain the disconnect between belief and practice, where teachers report one thing and do another in their classrooms (Hutner & Markman, Under Revision). Within a theory of cognitive representation, this disconnect may not be a result of social desirability bias. More importantly, however, is that the first step in helping teachers enact reform oriented practices is for them to have mediating states that correspond to reform oriented practices (Ericsson & Simon, 1993).

From the representational perspective, interviews provide a host of information about the content of a teachers mediating states and goal systems. Of equal importance is what teachers do not say (Rubin & Rubin, 1995). On this view, there is a difference between those traditional teachers who can report reform oriented mediating states and those who cannot. Further drawing from the representational framework, interviews provide insight into conscious cognitive processes of people. What are participants paying attention to? On what terms do they understand and interact with the social world? What cognitive policies do they hold commitments to as they navigate the complex set of demands placed on them by the school setting?

At the same time, the cognitive approach to this study recognizes there exist limitations to what interviews can provide information on. Nisbett and Wilson (1977) show that people are unreliable in reporting the reasons for their actions. Ericsson and Simon (1993) continue that as the time interval between action and an interview related to said action increases, the reliability of those self-reports decreases. Both concur that people are unreliable in retrospectively discussing the reasons for actions.

Within the field of educational research, the implication is that asking teachers why they did something in the classroom after the fact is less than reliable. According to

Nisbett and Wilson (1977), people unconsciously make up reasons that seem plausible when describing why they acted in such ways in the past. This applies to teachers as well. Thus, when asking about occurrences in the past, there is a strong likelihood of error in the answer.

This does not mean that asking about events that occurred in the past is pointless. On the contrary, people in organizations operate via a shadow of the past (March & Simon, 1993). *The key, then, to interviewing about past events is not to ask why someone did something in the past, but if and how said past event informs how they hope to act in the future.*

On the Role of Observation

"Through direct observations the inquirer is better able to understand and capture the context within which people interact" (Patton, 2002, p. 262). The researcher is able to get a sense of the organizational milieu that teachers work within on a daily basis. They are then able to describe the social interactions of the participants, as well as the place in which those interactions take place. As the setting for social interaction is crucial to understanding cognition, qualitative researchers taking cognitive approaches are behest to take account of the setting in which cognition occurs.

There are, however, significant limitations to observation as it relates to teacher cognition studies. Traditional approaches to understanding teacher cognition often assume that mediating states of various kinds can be inferred via observation of teachers in the classroom (Alonzo, et al., 2012; Richardson, 1996b). This approach derives from traditional notions of the relationship between teacher thinking and teacher action within the classroom, where teachers maintain conscious control over the course of events as they unfold during teaching.

However, many have begun to warn against making these types of inferences, referred to as the fundamental attribution error. The fundamental attribution error is, when explaining the actions of another, there is a tendency to attribute the cause of those actions to their mediating states (i.e. knowledge or beliefs, among others) and to understate the role the environment has played in the observed behavior (Gilbert & Malone, 1995; Hiebert & Morris, 2012; Kennedy, 2010; Ross & Nisbett, 1991). In studies on teachers, the fundamental attribution error often manifests itself in attributing classroom action to the (lack of) knowledge, beliefs, motivations, or PCK of the teacher being observed as opposed to contextual and situational factors.

What this means for research on teachers is that *we have limited ability to make claims about teachers cognitive processes based upon observation of their teaching.*

Within this study observations allowed for a detailed description of the teaching context. Thus, I was able to identify patterns of interaction within the school's at which student teachers were placed at and describe those patterns for readers. I was also able to describe certain constraints as they manifest themselves physically for student teachers. For instance, I can describe the student-teacher ratio for their classrooms, the available lab materials and technology, among other things. I can also get an idea for how time is structured and shared within the school each student teacher works at.

On the Role of Artifacts

"Through inscriptions that travel between places and between time, texts mediate meanings and actions between people" (Bazerman, 2006, p. 77). Texts, or physical artifacts, are the inscription of cognitive processes of one person into a physical media that influence the cognitive processes of another person at another point in time and/or space (Bazerman, 2006; Hutchins, 1995). Halverson and Clifford (2006) continue that locally created artifacts, such as curricula, are powerful influences on the thinking of teachers and administrators.

Furthermore, the creation of a physical artifact, be it a lesson plan, lab guide, portfolio, or assignment for a class, is a conscious cognitive process. One must devote conscious thought to the process of creating said artifact. Thus, there is a direct relationship between what someone is thinking and the creation of the artifact.

Within this research project, then, artifacts played a valuable role in ascertaining the goal systems of student teachers as they reflect and plan for their first year of teaching. Physical artifacts provide some insight into their thinking and what they are attending to, as their curricular creations will fall somewhere between doing exactly what their cooperating teacher would have done and the lesson they would create absent any constrains possible for any given topic.

Artifacts play a second role in this study as an avenue for triangulation. Willis (2007) mentions that notions of triangulation are particularly pertinent for qualitative researchers coming from postpositivist perspectives. In this view, triangulation prevents the researcher from drawing unsupported conclusions (Willis, 2007). "Triangulating across data sources imbues confidence in the findings, interpretations, and conclusions" (Lanier, 2008, p.110). Thus, artifacts serve as a source of triangulation for the claims made and the patterns identified. Unlike observations, there is a strong degree of correspondence between conscious thinking and the creation of an artifact.

On the Relationship between Interviews and Observations/Artifacts

Some may read the above discussion and ask if classroom observations have any relationship to interviews. This is a misunderstanding of the attribution error. What the attribution error suggests is that, when observing a teacher, I cannot make claims regarding the teacher's cognitive processes. This does not, however, imply that the teacher and I have wholly different views of *what actually happened in the classroom.* This means that classroom observations allow me to see events that may influence teachers as they reflect upon past events and plan for about future actions.

Thus, classroom observations informed interviews from the perspective that they provide a common experience upon which both the researcher and teacher negotiate meaning about the teachers experiences. In other words, observation helped me understand the relationship between the teacher and the context, as viewed from the perspective of the teacher.

One additional caveat regarding the relationship of observations to interviews. The salience of events may have differed between myself and the student teacher during a classroom observation. Something I viewed as important may be dismissed by the teacher. And, something I viewed as unimportant may be particularly salient to the teacher. Because this study is an investigation into the influences on teachers thinking about future actions, this distinction is not to be taken lightly.

When conducting interviews regarding observations, it was important to allow the student teacher I was conversing with to describe those events that were most salient for them, as opposed to asking about those events I deemed most salient. Later on in the interview, those things that I found to be important from a theoretical point of view are then open for discussion.

On the relationship between physical artifacts and interviewing, the issue of the attribution error is not as cumbersome. Thus, questions regarding the review of physical artifacts can seek to ask why the student teacher created the artifact they did. Also of importance are questions of the degree to which they plan on using classroom artifacts in the future teaching.

PARTICIPANTS AND SETTINGS

Four student teachers during the Spring 2014 semester participated in this study. All four participants were undergraduates at Big State University (BSU), a large state university in Capital City, the capital city of Big State. BSU has a total undergraduate population just over 40,000 students, the vast majority of which come from Big State. Approximately 50% of the students at BSU are classified as white, while the white population of Big State is closer to 45%. Hispanic and black students are particularly underrepresented at Big State, as they make up approximately 20% and 5% of the student body at BSU, while comprising 40% and 12% of the general population, respectively.

Big State University's Teacher Education Program

The teacher education program is a joint math-science teacher preparation program that prepares students to become middle or high school teachers. All students within BSU's teacher education program major in a science field (i.e. biology, chemistry, astronomy) while working toward their certification via the teacher education program at BSU.

The science teacher education program at BSU promotes a vision of equitable science instruction through the use of an inquiry approach to teaching and learning science. With respect to inquiry, the stated goal of BSU's science and math teacher education program is for students to "understand the fundamental nature and importance of inquiry in all the work that scientists and mathematicians do. Inquiry uses hands-on investigation, problem-solving, and reasoning to enhance student mastery of the content and concepts of STEM subjects" (BSU Teacher Education Website, 11/15/2014). Furthermore, according to the website, inquiry is seen as a gateway to equitable science instruction and is emphasized to students as a mechanism for overcoming various achievement gaps in the sciences.

Teacher Education Coursework

Students completed 12 semester-hours of pedagogical coursework as part of the BSU teacher education program. Due to state legislation limiting the number of semester-hours students can spend in secondary teacher education courses, the introductory courses in the BSU teacher education program were limited to one semester-hour and two semester-hours, respectively. During the introductory courses, students were introduced to the first of two instructional models that the BSU teacher education program promoted to their preservice teachers as vehicles for delivering inquiry based, equitable science instruction: the 5E learning cycle (Bybee, et al., 2006). The 5E model was particularly salient for the students in the BSU teacher education program, as they are asked to design lessons in the 5E format throughout their coursework. Students in each of the two introductory courses are required to complete a field experience of five hours in the classroom, comprised of two observations of a cooperating teacher and three opportunities to teach their cooperating teacher's students. For the field component, students are paired together and work cooperatively to both plan and teach 5E formatted lessons for the students in their cooperating teacher's class.

The two mid-program courses in the BSU teacher education sequence that students were required to take were each three semester hours, and expose students in the program to the literature base on teaching science for the first time. One of the two mid-program courses focused on helping preservice teachers to increase their "understanding of current theories of learning and conceptual development" (BSU Teacher Education Website, 5/5/2015), and has no associated field component. The second mid-program course:

> Allows you to see how theories explored in [the previous course] play out in classrooms. You will design and implement instructional activities informed by your understanding of what it means to know and learn in STEM areas, and you will then evaluate the outcomes of those activities. You will also consider frameworks for thinking about equity issues in the classroom and larger school

settings, learn strategies for teaching students of diverse backgrounds equitably, and use technologies to build relationships among teachers and students. (BSU Teacher Education Website, 5/5/2015).

This second mid-program course does have a field experience. Again, students work in pairs to cooperatively plan and teach a 5E lesson plan three times during the semester.

The final course in the teacher education sequence is a capstone course on Project Based Instruction (Barron, Schwartz, Vye, Moore, Petrosino, Zech, et al., 1998; Krajcik & Blumenfeld, 2006). In the PBI course, students are to take what they have learned in their previous courses and field experiences and apply this knowledge to extended instructional timeframes, thereby developing units as opposed to individual lessons. During this course, like the other courses in the BSU teacher education sequence, students engaged in a field experience where they planned and delivered three lessons cooperatively with another student. Unlike the previous field experiences, during the field experience for the PBI course, students are asked to teach a modified three day PBI unit, taught over consecutive days in their cooperating teacher's classroom.

The two instructional models—5E and PBI—are seen as particularly useful for integrating scientific inquiry with topics relevant to K-12 students, thereby promoting equitable science education for all students the BSU graduates will someday teach. At the same time, BSU's teacher education program does expose students to pedagogical concepts such as scientific literacy or socio-scientific issues. This does not mean that students are not learning about methods to promote scientific literacy or two integrate socio-scientific issues into their classrooms. For example, while the PBI course does not require work toward scientific literacy per se, BSU preservice teachers are instructed to think about the possibility of driving questions that broaden the scope of scientific understandings as it informs other social endeavors. Thus, driving questions can relate to the maintenance and health of local water systems, or the civic demands for renewable, clean energy.

Unlike other teacher education programs, the program at BSU did not have separate courses devoted to issues such as assessment or classroom management. Instead, students were asked to reflect upon these issues throughout the program. Each course would build upon and refine the knowledge of the preservice teachers related to issues of assessment and classroom management. Thus, these are themes that ran throughout the BSU teacher education programs, and students would continuously engage with these issues as they become more skilled and knowledgeable in their teaching.

Students in BSU's teacher education program were also encouraged to think about issues of diversity and culturally relevant or emancipatory pedagogies. During their course work, students read works by Paulo Freire and Jean Anyon, among others. At the same time, unlike other teacher preparation programs at BSU, the math-science program was not as explicit in its mission to prepare teachers to use culturally relevant pedagogies, such as those put forth by Ladson-Billings (1995). And, similar to the issues of classroom management and assessment mentioned above, there was no specific course dedicated to issues of diversity—instead, these themes wove throughout the course sequence in the BSU teacher education program.

The Student Teaching Semester

The student teaching semester is the last semester of BSU's teacher preparation program. Student teachers in science are assigned to a cooperating teacher for the entirety of the school semester. They are required to be at the school for 20 hours a week (Seminar 1), with most students choosing to go for four hours each day. Student teachers are also expected to teach two classes on their own for 12 weeks during the semester. As the student teaching seminar only requires students spend half the day at their cooperating campus, many students use the additional afternoon time to engage in internships related to teaching science. However, there are some students who use the remainder of the day to take a course or two required for their content major.

Based upon the syllabus for the student teaching semester (see "Appendix A[6]"), there are two main components to the student teachers: the field experience and the weekly seminar. In order to successfully complete the field experience, the student teachers needed to receive a passing evaluation from their cooperating teacher and an external evaluator hired by Big State University. Student teachers also needed to submit weekly lesson plans to the faculty members in charge of the student teaching semester, Tori and Stacy. Interestingly, these weekly lesson plans were not required to be in the 5E format, although student teachers could choose to use 5E. Instead, student teachers submitted a lesson plan using the "PLAN" format: a "Prompt" to begin class; a "Learning

[6] Any identifiers in the syllabus have been replaced with pseudonyms to protect the anonymity of the setting and participants. The pseudonyms have been placed in italics in the syllabus to indicate where changes have been made.

Activity" that structures much of the class; and, finally, an "eNding" to summarize the day's lesson and evaluate student learning (Seminar 1).

The second structural component of the student teaching semester was a weekly, 90 minute long seminar. The seminar was led by two clinical faculty members, Tori and Stacy, with Tori often taking the lead in front of the seminar group. Officially, Tori was the lead for student teachers in math, while Stacy was the lead for student teachers in science. In actuality, the two shared responsibility for all student teachers, regardless of their subject matter specialty. As Tori describes their dynamic:

> Stacy and I are the instructors of the course. She's the science person, I'm the math person, but we are both responsible for going out and observing every single student teacher a minimum of one time. Stacy often goes out more because she is also the induction [support] person, so she'll go out and observe all of them and then she'll go back and observe as many of the science people a second time as possible. I go out and observe them one time. My role, is a large part of it is administrative (Interview 1, May).

By administrative, Tori meant that she make sure student teachers complete their portfolio requirements on time, and handles information relevant to student teachers applying for their certification from Big State. By induction, Tori was referencing the BSU new teacher induction support program—both formal workshops held periodically during the school year and informal assistance when necessary—that Stacy is responsible for.

The portfolio plays a prominent role in structuring the student teaching seminar, as it is the main requirement to successfully complete the seminar component of the student teaching semester. When I asked Stacy if there were any formal objectives for the student teaching course, her reply was "no, not that I know of. Again, we follow the guidance of the portfolio" (Interview 1, May). Stacy continued that the portfolio "emphasizes lesson structure. It emphasizes implementation of the lesson and then it emphasizes classroom environment as well as content" (Interview 1, May). The seminar was largely viewed by Tori and Stacy as an opportunity to help students look "at this culminating final portfolio as a professional development tool" (Tori, Interview 1, May). This focus on the portfolio was quite evident during seminar, as discussion of the portfolio took up large chunks of seminar time during the first 10 weeks of a 15 week semester. It is also important to mention that the portfolio was not graded by current faculty at BSU. Instead, students submit to an online system, where their responses are provided to a grader—a current or former science teacher who reviewed each component of the portfolio.

Finally, Tori and Stacy viewed the student teaching seminar from a practical standpoint as opposed to a reflective one. As Tori mentioned, "I am constantly, I guess, pushing against the idea of making the seminar too heady" (Interview 1, May). Given this priority of both Tori and Stacy, the majority of the time not spent talking about the portfolio was spent working individually or in small groups on tasks that the students themselves deemed most important. The choice was made to structure seminar in this way so that:

> Students have the flexibility to work on what they need to work on. We try and focus it on a topic, like classroom environment, and we have a variety of things that they can interact with that can help them. If they feel they want to read something, we have resources available for them to read. If they want to watch a video on something, we have video clips of teachers talking about particular topics. If they want to sit with a group of their peers and work on lesson plans, they can do that. If they want to work on their portfolio, they can do that. The beauty of that, it helps us hit what I consider the primary focus of the seminar, which is individualizing it to the needs of the student (Tori, Interview 1, May).

This often manifested itself in student teachers working on grading papers, lesson plans for the next day, or their upcoming portfolio entries.

To be clear, this is not to imply that no reflection occurred on behalf of the student teachers in this study during the course of the student teaching semester. Instead, it is to say that student teachers were not formally guided in their reflection by Tori and Stacy during the seminar. As a result, students were not given the opportunity to engage in reflection on their teaching in larger groups with the guidance of Tori and Stacy. Instead, students were likely to reflect informally as they gathered before and after seminar, when talking with their cooperating teacher, or on their own time.

Participants

For this study, four undergraduate preservice teachers were purposefully chosen as they were likely to provide “information-rich” opportunities for inquiry (Patton, 2002). As Patton (2002) describes it, “information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the inquiry" (p. 230). Given that the issue of central importance is goal systems of individuals, participants were valued for their willingness to speak at length, and in great detail about the cognitive policies they hopped to pursue during their first year teaching. To identify possible participants, I asked Big State University faculty to recommend preservice teachers who are thoughtful about their teaching and had demonstrated a desire to use the methods promoted in the BSU teacher education program in both their student teaching placement site and their future classroom.

A.C.

During the student teaching semester, A.C. was a 23 year old male, who identified as "Hispanic-White because there's no other option. I'm a mix of everything, but I guess Hispanic" (Interview 3). A.C. went to high school in Border City, a large city on the U.S.-Mexico border in Big State. A.C. followed in his older sister's footsteps by attending BSU, initially intending to go to pharmacy school after completing his bachelor's degree in biology. It was on his sister's advice that he took his first course in teacher education, as she too had graduated from the BSU teacher education program, and had moved back to Border City to become a science teacher. Upon graduation, A.C. wanted to return to Border City to become a biology teacher.

Officially, A.C. was assigned to teach aquatic science with Mr. Slater at Valley high school, in Capital City. However, A.C. intended to teach biology, so unlike his peers, A.C. spent the entire day at Valley, taking full responsibility for the aquatic science courses while also team-teaching the biology courses with Mr. Slater. Valley high school has a student population of just over 1500 students, 75% percent of whom are classified by Big State as Hispanic. The state further reports that over 66% of students are economically disadvantaged, and 75% of students are considered at-risk. Finally, Valley high school met the minimum requirements for students passing the Big State Big Test (BSBT)—Big States state-wide end of year assessment—with over 80% of Valley students passing the science portion of the BSBT. However, Valley's passing rate lagged behind those of both the state and district averages.

A.C.'s cooperating teacher, Mr. Slater, was a graduate of the BSU teacher education program as well. During his 11 years of teaching experience, Mr. Slater had taught mostly biology, but also forensic science and aquatic science. Mr. Slater felt that it was important for student teachers, A.C. included, to learn about the realities of teaching. He mentioned that:

> Coming from the university, especially [BSU's teacher education program] is like such lofty goals and such high expectations. It can be a little too much academia. Then, when you get in the classroom, especially at a high needs or title I school, you see where students are at (Mr. Slater, interview 1, May).

Mr. Slater further suggested that his role is to help A.C. learn to be successful the following year, first by modeling appropriate teaching practice and then slowly pulling back. Mr. Slater would also mention that A.C. was quite adept at working with the students at Valley, and that he reduced his presence in the classroom more quickly than he had expected.

During my visits to Valley high school, it was clear that A.C. taught in a science room. There were sinks and lab benches surrounding the room. Scattered around the classroom were also various aquaria with both fresh and salt water habitats as well as a few terraria containing land animals. On the board in the back of the classroom was the agenda for each day. A.C. also made a power point for each day, which was projected onto the screen at the front of the room as students walk in.

A.C. has a relaxed, yet professional style to interacting with his students, and it is clear that his students enjoy having him as a teacher. As an example, during my first observation, when A.C. asked the students if they had any questions, one student raised their hand and asked A.C. "how long he has been a 'G' [a slang term the student used in a humorous and positive manner]" (observation 1)? A.C. laughed briefly, then redirected his students by reminding them he meant questions relevant to class. During my second observation, closer to the end of the semester, his students asked A.C. if he was going to teach at Valley during the upcoming school year, again showing the strong relationship that A.C. developed with his students.

Of note, during our final interview, A.C. had applied for biology teaching positions at several schools in Border City, yet had not received any offers. Furthermore, he expressed a desire to only teach in Border City, and felt confident that he would land a teaching position for the fall.

Zach

At the time of this study, Zach was a 23 year old male, who identified as a "white American person" while recognizing his mother was Japanese. Zach grew up in and attended high school in a middle class suburb of Corporate City, one of Big State's largest cities with a large presence of technology and industrial companies. Upon entering BSU as a freshman, Zach was a biology major with a premed concentration, intending to enter medical school upon graduation. During his student teaching semester, Zach had not ruled out eventually attending medical school, but it was not part of his immediate plans. Zach enjoyed teaching, and planned to teach chemistry, his preference, or biology in the fall.

Zach was assigned to Mr. Morris' astronomy class at Bayside high school, located in a school district just outside Capital City. Due to his financial situation, Zach also worked as a teaching assistant for a science methods course in the BSU elementary education program during the student teaching semester. His teaching assistant responsibilities required that he attended the classes he was assigned to—classes that met Monday and Wednesday afternoons and Tuesday and Thursday mornings. As such, he would need to team-teach all of the classes with his cooperating teacher, as opposed to taking sole responsibility for a subset of the courses his cooperating teacher was responsible.

While astronomy not something Zach intended to teach his first year, he had met Mr. Morris through previous field experience and felt that they had a strong rapport and that Mr. Morris would be an effective mentor during the student teaching semester. Mr. Morris was also willing to accommodate Zach's unique scheduling constraints. Mr. Morris was in his seventh year of teaching, having taught astronomy, physics, chemistry, environmental science and scientific research and design previously. During the 2013-

2014 school year, Mr. Morris was assigned to teach only astronomy. Mr. Morris felt that the most important thing for Zach to learn over the course of the semester that it is okay to fail, for a lesson not to go well, and to have a bad day. He would recall his own student teaching experience:

> I had so much success as an undergraduate teacher, people patting me on the back and whatever. And I was a great undergraduate teacher. But when I got my own classroom and I failed, it was devastating. I was like "maybe I'm not as good as I think." Which I wasn't, and I'm probably still not. But the idea that it's okay to fail and that you learn from that. I mean, you have four periods, and usually the first time you do something, it's not going to work out (Mr. Morris, May interview).

Thus, Mr. Morris encouraged Zach to experiment with different approaches to teaching class.

Bayside high school is part of the New Tech Network of schools undertaking a PBI based school wide reform. Because of this, students must apply to attend Bayside high from across the Bayside district, and Bayside is able to limit their student body population to 350 students. Of those, approximately 50% are Hispanic, 23% are African-American and 23% are white, as reported by Big State. Furthermore, 29% of the students at Bayside are considered at-risk and 55% are economically disadvantaged. The percentage of students passing the BSBT in all subjects during the 2013-2014 academic year not only met the minimum standard for all schools in Big State, but exceeded both the district and state averages in every tested area.

While observing Zach at Bayside, I noticed the room Zach student taught in was a small classroom that was clearly not a science room, as there were no lab stations, sinks, or other structural indicators that science was taught in the room. His classroom was located in the annex gym building, and it was easy to hear the basketball being played next door. The room was decorated with posters related to astronomy topics such as stellar evolution, gravity wells, and space-based telescopes, among other topics. There were also exemplary student projects hanging on the walls and from the ceiling, including projects on solar structure and the solar system. Also on the board was a list of the day's objectives and the standards from the BSSS that the day's class would cover.

As Zach would tell me between classes on my first observation, Bayside received a grant to purchase iPads for each student in the school. This, he said, was so students would be able to use the most up-to-date technology in the completion of their projects as part of Bayside's commitment to the PBI approach. During each of my observations, students were actively engaged with the project on the iPads, as opposed to using them for less academic purposes.

Zach has a very relaxed approach to his classroom management, and is at ease with his students. Before class starts, students interact with Zach in a friendly manner, talking about topics unrelated to his class. Zach is also willing to joke with his students, adding to the rapport with his students. This seems to help foster classroom conversations related to scientific issues as well. As they are comfortable with Zach, his students are willing to share their ideas publicly during class.

Prior to our final interview, Zach had applied for chemistry and biology teaching jobs in many cities throughout Big State, including Capital City and Corporate City. At the time of our final interview, Zach had been on multiple job interviews, but had yet to receive an offer.

Kelly

At the time of the study, Kelly was a 23 year old Asian woman. Kelly graduated high school from a school in Energy City, a very large city that plays a substantial role in the energy infrastructure of the United States. Unlike the other participants in this study, Kelly did not live her entire life in Big State, having moved from another large US state when she was in middle school. Kelly entered BSU as a freshman with the desire to major in chemistry in order to become a chemistry teacher, in large part due to the inspiration from her own high school chemistry teacher. Thus, Kelly expected to teach chemistry the following fall.

Kelly was assigned to student teach chemistry with Mr. Kapowski at Sands high school in Capital City. Like Kelly, Mr. Kapowski was a graduate of the BSU teacher education program. Currently in his ninth year of teaching, along with chemistry, Mr. Kapowski had previously taught physics, biology, AP environmental science, geology, meteorology, oceanography, and aquatic science. When asked to discuss what he felt was most important for Kelly to learn, Mr. Kapowski mentioned building relationships [with students] because:

> Having been through the [BSU teacher education] program, that's the one thing that none of the classes can give you—insight into how to build a relationship

> with students. Relate with them and actually reach out and get them. Because all the other courses you take, you see kids at most for a week in a semester (Mr. Kapowski, May interview).

Mr. Kapowski would further elaborate that learning to build relationships with students is the most important thing to learn, because when you get your own classroom, if you are unable to build relationships with students, you will be highly unlikely to succeed in teaching them anything.

Sands high school has a student population just under 2,200, with approximately 45% of students classified as white and 45% classified as Hispanic. Furthermore, 33% of students at Sands are considered economically disadvantaged and 53% are considered at risk students, as reported by Big State. Finally, the percentage of students passing each subject area on the BSBT both met the minimum standard required and exceeded the state and district averages.

Mr. Kapowski taught chemistry in one of the renovated chemistry rooms at Sands high school. As a result, Kelly taught in a room replete with lab stations and a fume hood that was accessible from both her classroom and the chemical storage room next door (observation 1). The chemistry room was full of cabinets containing chemistry equipment such as glassware, balances, and ring stands.

During my observations, it was clear that Kelly had established a strong set of routines and was capable at managing a class. During my first observation, an administrator came to the class to speak with Kelly. While Kelly exited the hallway, her students remained at their desk, working quietly. It was also evident during my second classroom observation that Kelly engaged her students in chemistry labs quite often and had a set of routines established such that her students were familiar with how to conduct themselves in a laboratory setting. One example was the routine to put their data into an excel spreadsheet that was projected on the overhead, a routine which Kelly did not need to remind students of as they had internalized that as part of their laboratory routines. As such, Kelly had a very calm and productive classroom environment.

Finally, prior to our interview, Kelly had accepted a job for the upcoming fall semester at Private high school, a private high school in Capital City.

Jessie

At the time of the study, Jessie was a 24 year old white female. She too graduated high school in Energy City. Jessie majored in biology at Big State, but unlike the other student teachers in this study, she hoped to teach middle school science, preferably 8th grade composite science at a school in Energy City. Both of Jessie's parents were teachers, and she mentioned that she always knew she wanted to follow in their footsteps and enter the teaching profession.

Jessie was assigned to student teach with Ms. Spano in 8th grade composite science at JFK middle school, located in a suburban district just outside Capital City. Jessie had been assigned to Ms. Spano's class as part of an internship program through BSU's teacher education program. As such, Jessie had worked with Ms. Spano for two years prior to her student teaching semester. Ms. Spano has been in education for 14 years, 9 as a middle school science teacher with a 5 year stint as an administrator. Ms. Spano returned to the classroom because she realized "I miss the kids and I am happy when I am with kids" (May interview). Thus, she gave up her role as an administrator and had returned to teaching middle school science.

Ms. Spano graduated from Big State University, majoring in biology with a teaching option. She also wanted to make it clear that the BSU teacher education program had undergone considerable changes since she was an undergraduate, and that the current incarnation bears little resemblance to the program she went through. While Jessie was the first student teacher Ms. Spano had supervised, she too had well thought out notions of what she wanted Jessie to get from the semester. Ms. Spano suggested that:

> The university can teach you the pedagogy, but there is an art to teaching as well. And so I hope that she'll be able to pick up the art portion of it. And, what I mean by that is how to truly interact and what is a middle school student and how to interact with a middle school student (May interview).

Ms. Spano hoped to model for Jessie what the art of working with middle school students entailed.

JFK middle school had a student body of approximately 900 students, 83% of whom are classified as Hispanic by Big State. Furthermore, 83% of the student body is considered economically disadvantaged and 73% are considered at risk, as reported by Big State. During the 2013-2014 academic year, the percentage of students passing the BSBT met the minimum required by Big State for all subject areas. Their passing rates were slightly better than the district average for middle school students, while slightly below the state average.

Upon entering the classroom where Jessie student taught, the first thing I noted was the agenda for the day on the board along with the amount of time dedicate to each portion of class. In looking around the rest of the room, Jessie taught in a science classroom that was a bit on the older and smaller side. It appeared as if some of the seven sinks did not work. Jessie's cooperating teacher, Ms. Spano, also had secured two computers for use during class, and they blocked two of the lab stations.

As part of the schools procedures, each teacher had to stand at their door and welcome students into their classroom with a "fist bump." This was part of a school wide effort to help teachers build their rapport with their students, something that came naturally to Jessie. At the same time, Jessie was still developing her craft with regards to classroom management. During both observations, Ms. Spano stepped in to remind her students to calm down and continue working.

Finally, prior to our final interview, Jessie had accepted a job teaching 6^{th} and 7^{th} grade composite science at Magnet middle school, a magnet middle school in Energy City.

DATA COLLECTION

The main source for data reported in Chapter 4 (findings) are interviews with the four student teachers. Because the project seeks to ascertain the goal systems of the student teachers and the cognitive policies that comprise them, the most effective method for gaining such insight comes from interviews. The teaching portfolios were also used in an effort to gain insight into the goal systems of the student teachers. Observation data was also collected from both the seminar and the field sites, but is not part of the data analysis, nor is this data reported in the findings chapter.

Interviews

Interviews were used to gain insight into the conscious mediating states of student teachers. A semi-structured interview technique (Merriam, 2009; Rubin & Rubin, 2005) was used to guide each interview. This allowed for the interview to focus on topics that were of particular interest to this research project by the researcher, but also allowed for flexibility in interview topics, such that participants took the conversation down avenues that were salient to them. At the same time, recognizing that the student teachers are responding to my questions, I paid attention to ask the same questions in similar manner for each interview.

Because the purpose of the study was to gain insight into the *goal systems for the first year teaching*, and not the goal systems for student teaching, I regularly prompted the student teachers to think about implications for their first year. Thus, if the interview went in an unanticipated direction, I would cue the student teacher to reflect on how that informed their cognitive policies for the upcoming school year. I further attempted to highlight potential conflicts, by prompting the student teachers to consider hypothetical constraints preventing the achievement of their goals.

Taking cues from both Brown (2010) and Saka (2007), interviews were conducted with each student teacher three times over the course of the student teaching semester: once in January, once in March, and once in May after the completion of the student teaching field experience. My first interview with A.C. was unexpectedly cut short, and as such was broken up into two pieces: part 1 and part 2. The second half of the interview took place two days after the first part. Also of note is that the findings in chapter 4 report the goal systems of student teachers in January and May only.

In order to gain a greater understanding of the school milieu and expectations of the cooperating teachers, one interview was conducted with the cooperating teacher for each student teacher. An interview was also conducted with the two seminar faculty—Tori and Stacy—to gain a greater understanding of the aims of the student teaching seminar.

Recognizing the value in my participant's times, I restricted the interviews to approximately one hour. All interviews were recorded using a digital voice recorder. Please see appendices B-D for a copy of the interview protocol for the initial interview with the main participants, cooperating teacher, and seminar course instructor, respectively.

Physical Artifacts

The creation of a physical artifact is a conscious effort on behalf of the creator of such artifact, and as such are reflective of cognitive processes in multiple ways. First, artifacts created by student teachers may be indicative of self-reflection processes, such as portfolio responses. Second, artifacts created by the student teacher may be used to influence the cognition of their students, such as lesson plans or student handouts. Finally, artifacts may be created by others to influence the cognition of student teachers thinking, such as feedback of observed teaching behavior.

Several types of physical artifacts were collected as data sources for this study. These artifacts provide an avenue toward triangulation, as they provide another source of data upon which to base findings. Rozelle (2010), in his study of student teachers, collected numerous artifacts from the student teaching semester. These artifacts included any assignments for the teacher education course for the semester; written feedback on classroom teaching by the seminar faculty and cooperating teacher; and self-evaluation and reflections of the student teacher. Blevins (2011), in her study of novice teachers, also collected any documents that were used in their classrooms, including lesson plans and classroom handouts. Blevins (2011) also collected archival data from teacher education courses of her participants, including classroom assignments and reflections.

Following the lead of Rozelle (2010) and Blevins (2011), the following physical artifacts were collected from all participants: (1) all lesson plans and curricular materials (i.e. student worksheets) used in their field placement classes; (2) written feedback from the cooperating teacher or seminar faculty; and (3) any artifact created by students teachers as part of the requirements for successful completion of the student teaching seminar. For the results presented in Chapter 4, only the portfolio was used as a source of cognitive policies making up the goal systems of the student teachers. This choice was made for two reasons. First, claims regarding the cognition of student teacher can only be made with respect to artifacts created by the student teachers themselves. Second, the portfolio represents the ideal practice of the student teacher, unconstrained by the requirements of their cooperating teacher. It was made quite clear to the student teachers during the first seminar that they should defer to the pedagogical and curricular approach of their cooperating teacher. As such, lesson plans and curricular artifacts from the student teaching semester may represent the goal systems of the cooperating teacher as much as it does the student teacher themselves.

Observations

As mentioned earlier in this chapter, observations serve to provide a firsthand account of the school context that student teachers work and learn in. Observations taking place at the school focused on gaining a deeper understanding of the organizational culture and context for each student teacher. Observations focused on the other people that the student teacher worked with (including students) and the nature of those interactions. Nespor (2006) also recommends paying attention to how people and things move through space and time, as these movements provide additional insights into how people construct their worlds.

Observations occurring within the school site focused on: (1) the spaces student teachers inhabit while present at the school (e.g. the classroom space or the faculty lounge, among others) and whom else works within those spaces at the same time; (2) who the student teachers interacted with while present at the school site and the nature of those interactions; (3) how time and resources were budgeted by the student teacher and organization; and (4) other aspects of the school site that emerged during the study.

Each student teacher was observed for a full day at their school on two occasions. Each observation occurred during the second half of the student teaching semester. This was done to allow the student teacher to integrate into the school and classroom cultures without my presence. This also provided ample time for routines to develop for each student teacher, thus allowing me access to typical days after the student teachers had become comfortable in both the physical and social environment of their school.

Unlike many other studies that involve classroom observations, this study is not concerned with the actual teaching enacted by the student teachers per se. Observations of the student teacher participants engaged in teaching were conducted for two reasons. First, this provided a firsthand account of the nature of the interaction between the student teachers and their K-12 students. Second, this allowed for thick description of the setting, as well as identifying the physical and social environments that these student teachers inhabited, such as the presence of laboratory equipment and class sizes.

To be up front, classroom observations were not used to infer anything about the goal systems of participants. The extent of the claims to be made about cognition when observing a teacher teach are that the combination of mediating states, environmental states, and goal states interacted in a cognitive process, such that the end result was the behavior observed.

Rozelle (2010) also suggests undertaking observations during the student teaching seminar itself. I was present at each weekly seminar to observe the student teachers. The focus of observations during the student teaching seminar was: (1) to observe what things the university facilitators are having students reflect on; and (2) observation of occurrences that emerge from the seminar not explicitly mentioned in the syllabus.

As mentioned previously, Tori and Stacy—the faculty in charge of the seminar—approached the seminar hour as a chance to provide support for each student teacher at an individual level. Thus, the majority of the seminar was used for individual work time—

something that did not go unnoticed by the student teachers in this study. For example, during our second interview, Jessie mentioned that a "lot of it honestly is just work time, which isn't super helpful" (interview 2). This was a sentiment shared by the other student teachers, who did not understand why they needed to come to campus to work on things they could have worked on at school or at home. Because of this, the seminar did not prove as rich of a data source as I would have hoped.

Data Analysis

Within qualitative research, data analysis and data collection are not two separate stages of the research project. Instead, they are intimately linked (Blevins, 2011; Lanier, 2008; Merriam, 2009; Miles, et al., 2014; Patton, 2002; Saka, 2007; Rozelle, 2010; Willis, 2007). On this view, data analysis begins contemporaneously with data collection. Within the constant comparative method, data collection and analysis occur in a cyclical nature, where new data is compared against existing codes and themes. At the same time, the constant comparative method allows for researchers to identify new patterns in the data, and return to previous data for analysis. Finally, emerging themes from the data inform subsequent data collection, as the researcher seeks additional insights into emerging themes.

Coding

Codes are labels that assign meaning to chunks of data, allowing the researcher to condense the data in order to identify patterns and themes with the data. Miles and colleagues (2014) suggest a two cycle processes of coding. "First cycle coding methods are codes initially assigned to the data chunks. Second cycle coding methods generally work with the resulting first cycle codes themselves" (Miles, et al., 2014, p. 73).

Miles and colleagues (2014) suggest there is a distinction between deductive and inductive codes. Deductive codes emerge from the theoretical framework, and are often created prior to data collection. Inductive codes, on the other hand, emerge during data collection, and often reflect emerging understandings in the data. This study employed both types of codes.

An additional advantage of the constant comparison method is its allowance for the revision of codes. Again, turning to Miles and colleagues (2014) for guidance, during the constant comparison method, it may become apparent that "too many segments get the same code, thus creating the familiar problem of bulk" (p. 82). When this occurs, there is need to create subcodes and recode parts of the data. At the same time, the revision of codes may require the deletion or modification of one or more codes.

From Codes to Goal Systems

In Chapter 4, I will present goal systems comprised of multiple cognitive policies for each student teacher. It is important to first detail how these systems were created. This processes was guided by the approach to second cycle coding advocated by Miles and colleagues (2014). They identify for types of codes that typically emerge during the second cycle: (1) categories or themes; (2) causes/explanations; (3) relationships among people; and (4) theoretical constructs. Furthermore, they recognize there is often a great deal of overlap between the four types. In moving from first cycle codes to second cycle codes, Miles and colleagues (2014) recommend grouping first cycle codes into groups to build second cycle codes.

For this project, each chunk of data along with its corresponding first cycle code was placed upon a colored index card (using computer assistance), with the color corresponding to both the participant and the time of the interview (January, March, or May). All chunks were grouped together to identify those first cycle codes that occurred most frequently, with the color coding allowing for an easy way to visualize the occurrence of each code for each of the four participants. From here, first cycle codes were grouped together into second cycle codes.

Of the four types of second cycle codes identified by Miles and colleagues (2014), themes and categories emerged during the processes of moving from first cycle codes to second cycle codes. For example, first cycle codes such as PBI, 5E, engagement, inquiry, labs, and relevance, among others, were grouped together into a second cycle code of teacher education pedagogy. The three themes that were most prevalent across the four student teacher in this study—goal systems in response to teacher education, goal systems related to systemic reform, and goal systems related to the human dimension of the school organization—are reported in Chapter 4.

From here, the chunks were disaggregated by participant and interview, such that I was now only working with the data chunks included within a second cycle code for one interview at a time for one participant at a time. At this stage, I first identified those statements that were cognitive policies, as opposed to statements about beliefs or knowledge, among other possible statement types. Recall that Aarts and colleagues

(2004) suggest that a goal representations, including more abstract cognitive policies, can be both the actions a person will undertake at a future point in time as well as the desired outcomes of those actions. This is important as it provides guidance to what types of statements reflect cognitive policies, as opposed to statements reflecting mediating states. As an example of an action-based cognitive policy from Chapter 4, A.C. described how, "if you wanted to show them [students] a tornado or hurricane" (interview 1, pt. 2), he would use online simulations because you can't demonstrate a tornado in a classroom. This type of statement is a cognitive policy because it regards the actions he hopes to engage in at a future point in time. As an example of an outcome-based cognitive policy from Chapter 4, Zach mentioned he wanted students to be able to "tie back their ideas from whatever they're learning to whatever they actually see or do in real life" (interview 3). This type of statement is a cognitive policy because it describes an outcome that Zach hopes to bring about, namely students being able to make connections between in-school science and out of school experiences.

Carver and Scheier (1998) put forth the notion that goals representations, including cognitive policies can also reflect actions or outcomes that a person wants to avoid. Again, this is important, as it provides theoretical guidance for identifying statements made by each of the student teachers that are indicative of cognitive policies. As an example of a cognitive policy governing actions to avoid from Chapter 4, A.C. mentioned that he planned to eat lunch on his own most days because he "sat in some of the teacher's lounge conversations here and it's just like…it's a lot of bickering and a lot of complaining" (interview 1). Thus, A.C. expressed his cognitive policy to avoid engaging in the action of bickering and complaining. As an example of a cognitive policy from Chapter 4 regarding outcomes to avoid, Jessie would mention that she hoped that as a result of her teaching, “there were not content errors or misconceptions present in students’ thinking” (interview 1). Here, Jessie is expressing her cognitive policy of avoiding an undesirable outcome.

Finally, recall that this study treats goals and cognitive policies as distinct representational elements from belief and knowledge. Thus, it is important to identify those statements that were not cognitive policies. For example, in her teaching portfolio, Kelly discussed why PBI was a beneficial approach to teaching chemistry because “context plays an extremely important role in secondary education” (3/1/2014). This statement, however, is not a cognitive policy because it does not indicate future actions to engage in or avoid. Nor does this statement from Kelly indicate future outcomes to pursue or avoid. This does not mean there is no relationship between statements such as this and the cognitive policies of students in this study. Often, statements such as the one from Kelly are used to define or justify cognitive policies. However, unless such a statement could be matched to cognitive policies, it is not considered as part of the goal system of the person making the statement.

Upon identifying the cognitive policies of each student teacher, the next step was to look for hierarchical links between cognitive policies. These links would be expressed as a means/ends relationship, such that a lower level cognitive policy serves as a means toward the end of achieving a higher level cognitive policy. For example, a hypothetical statement such as “I use the 5E model because it allows me to implement inquiry” suggests that the 5E model is a means toward achieving the end of teaching through inquiry. Furthermore, if it was not clear that a means/ends relationship exists—despite the theoretical tendency for there to be one—then no concrete link was made.

During this stage of data analysis, I also looked for indications of goal conflict.. Again, drawing on the theoretical framework guiding this study, goal conflicts often are statements that indicate the satisfaction of one goal prohibits the satisfaction of a second goal (Gollwitzer & Moskowitz, 1996; Fishbach, et al., 2009). Thus, statements were considered indicative of a goal conflict if and when it was made clear that both cognitive policies could not be satisfied at the same time. Often, this manifested itself as statements indicative of the modification of one cognitive policy as a result of a stronger desire to pursue another cognitive policy. Furthermore, if they did not express a conflict between cognitive policies, despite the potential appearance of one to an outsider, I did not indicate the presence of a conflict.

ENSURING THE QUALITY OF RESEARCH

As discussed earlier in the chapter, within qualitative traditions, notions of reliability and validity are replaced with notions of credibility and trustworthiness. A study is credible and trustworthy to the extent that the findings seem plausible given the data reported. Credibility and trustworthiness are aided by the rigor of the research design via triangulation. There are, however, additional avenues to help establish credibility and reliability. There are three avenues that will be employed within this study.

Member Checking

Member checking is the process of allowing participants in a study to review data and findings. During the data collection period, member checking allows participants to review interview and observation data and provide additional clarity or insight into the data. After data analysis is complete, the second stage of member checking allows participants to review findings and conclusions, to see if they are congruent with their own experience. Participants are then given the opportunity to suggest alternative interpretations of the data.

Each participant was offered an opportunity to review the transcripts in full, but each declined. For a variety of factors, they each independently decided not to review the transcripts. To be upfront, part of this is likely due to the relationships that I built with each participant over the course of the semester, and the trust of my participants that I would represent their voices accurately. During the course of the semester, I would speak with each of my participants and let them know what my emerging notions were, and ask for their feedback on my thoughts. One example of this is that Kelly consistently uses the term "objectives" to refer to the state standards. Prior to data analysis, I made sure to check with Kelly that my interpretation of her use of the term objective was congruent with what she meant by objectives.

I did not ask my participants to read this manuscript. While they may have declined to do so, similar to their choice not to review transcripts, they may have accepted, given the more formal nature of the manuscript. I felt it was not fair to ask my participants to read over a document of this length in the midst of their first year teaching.

While I considered providing them with excerpts that dealt only with their own data, I eventually decided against this, as it would not provide a full account of the claims I am making about their cognition. Any articles that I create from the data reported here, or other data collected during this project, will be sent to each participant for their review in full.

Ethical Considerations

Another avenue toward credibility and trustworthiness is via the ethical responsibilities of the researcher. First, this study was approved by the university Institutional Review Board (IRB), to make sure it met federal, state, and university guidelines for the ethical conduct of research with human subjects. For a copy of the IRB approval, please see “Appendix E.”

Saka (2007) identified unique ethical considerations as part of working with novice teachers while attempting to maintain an objective stance as a detached observer. According to Saka (2007)

> This cloak of objectivity was comfortable until it became obvious that one of my participants was struggling in his work. The prevailing ineffective classroom management and teaching practices of my participant and his emotional struggles created a conflict in which I [Saka] realized that my researcher role and my role as friend and colleague were colliding. As I watched these practices unfold, I worked to find ways to support this teacher to improve his teaching. Although such interventions distorted my research methodologies, I interfered when I believed my involvement was in the interest of my participant…Thus, this study

> posed particular ethical dilemmas, ones I resolved by erring in favor of supporting these novice teachers (p. 105).

To some extent, the reality shock encountered by this participant in Saka's (2007) study is predicted by the two worlds phenomena described in Chapter 1. As student teachers encounter the realities of the job of teaching, they too are likely to have an experience similar to the one described by Saka (2007), as the ideals of novice teachers are confronted with the realities of the job.

Given my background as a teacher, my role was not strictly that of a researcher in the eyes of the student teachers participating in this study. To some extent, these novice teachers viewed me as a neutral party to whom they both expressed success and sought advice for improvement. This dilemma is similar to the one described by Saka (2007), where my role as researcher conflicted with a potential role as mentor. Following Saka's (2007) lead, I erred on the side of supporting new teachers as they negotiate the two worlds of student teaching.

For one student—Lisa—this meant suggesting that she end her participation in the study early. Lisa had a particularly difficult time and was struggling to successfully complete her student teaching assignment. I no longer felt that I could ask her to give me her time or to focus on my work when she clearly needed to focus on hers. This does not mean that I abandoned her. To the contrary, Lisa and I met more frequently after her role as a participant ended, freeing me to act in the role of a mentor to a much higher degree.

With respect to the other student teachers in this study, I would provide guidance if and when it was requested. Often times, it meant lending a sympathetic ear to one of my participants either before or after the weekly seminar met for the night. On a few occasions, the participants asked for more targeted advice on either classroom management or lesson ideas. Again taking my cue from Saka (2007), I chose to err on the side of supporting novice teachers.

RESEARCHER AS INSTRUMENT

The instruments used for data collection are implicit in theory development and the creation of facts (Kuhn, 1996). The choice of instrumentation for data collection delimits the realm of possible data. Not everything in the world counts as data, nor can it be measured by a specific instrument. Within qualitative research, it is the researcher themselves that are the instrument of data collection. Recognizing that all people bring with them a world view that influences their perceptions of events, it is important to be upfront of what my world view is and the experiences that have shaped it.

My Teacher Education Program

I initially started my undergraduate education as a social studies education major, and lucked into science education. The undergraduate program from which I received my B.S. in science education focused on science literacy, conceptual change, and the nature of science. I recall reading *The National Science Education Standards* during my undergraduate preparation, and can confirm via syllabi that I also read *Science for All Americans.*

My undergraduate program was a traditional one, in that I had both science specific teacher education courses as well as general pedagogical courses that I took with students of all disciplines. With respect to culturally relevant pedagogies, I took a course on teaching diverse populations and one on teaching content to students who do not speak English as their primary language. Both of these courses were part of the general pedagogical courses, as opposed to science specific. This is not to say there was no mention of issues of diversity or culturally responsive pedagogies within my science methods classes, but that I cannot recall them to the same degree.

I also had a content specialization in physics. In high school, I was exposed to Einstein's Theory of Special Relativity, and was fascinated by it. Thus, I decided to go into physics to explore these and related concepts in more depth. I also took these courses as part of my desire to bring topics such as special relativity to my high school students. I was troubled by the historical nature of much of science in the K-12 setting, as there was little modern physics, biology, or chemistry in the curriculum, and I wanted to change that.

I would also receive my M.S. in science education from the same school and faculty. It was during this time that I began to formalize my notions of what good science teaching looks like. I engaged at a much deeper level with the reform documents *Science for All Americans* and *The National Science Education Standards*, and thus was born my deep commitment to scientific literacy. This commitment was aided by my increasing appreciation of the nature of science as a human endeavor.

At this point, my curricular vision was largely solidified, in that I wanted to use reform oriented teaching practices to promote science literacy in my students. Learning science in my class would be valuable for both students who pursued a career in science and those who did not.

Teaching Experience

Following the apprenticeship of observation, I assumed I would teach in a school similar to the one I went to. More importantly, I thought I would teach classes like the ones I had—predominantly white, middle class students in honors and AP courses.

This was not the experience I had teaching. My student teaching semester I worked in a school that was approximately 50% African American, and 50% White. While I do not recall the exact level, I would estimate about 50% of students were on free or reduced lunch. I enjoyed my student teaching experience very much. So much so, that I took my first teaching job at the same school.

My first year teaching was not at all what I expected, and it is at this point that I truly felt tension between my ideal vision for teaching my students and the organizational reality of the school. During the third week of school, I had a public confrontation with an Assistant Principal at a faculty meeting. This meeting prompted me to question my commitment to teaching, and has shaped my career as a teacher educator, graduate student, and researcher to a very large degree. It was this incident that prompted my research interest into the policy and organizational contexts of public schooling, and my commitment to the improvement of teacher education.

At the end of the school year, I decided to leave the school and state, and moved to Austin, Texas where I became a teacher at a high minority, low income school. Reflecting on my experiences from the first year, I had a much more positive experience my second year teaching overall and my first at this new school. I was able to find space to teach for science literacy while working within the curricular constraints imposed by my district. I also had an incredibly supportive principal, with whom I still have a relationship.

Becoming a Teacher Educator and Researcher

I entered my doctoral program with a burgeoning interest in the influence of policy on teachers and their teaching. From my experience, I also felt that school based administration can play a large role in how teachers approach their classes. It was during this time that I began to clarify my understanding of both human cognition and organizational influence on cognition that have been detailed above.

More importantly, however, is the shadow of the past as it influences my own practices in the related arenas of teacher education and research on teachers. Specifically, my confrontation with my administrator has continued to shape my work in both realms. With respect to teacher education, it is largely this episode that has driven my desire to become a teacher educator. I have often felt that the field of teacher education largely prepares teachers for job conditions that do not exist. Thus, one of my goals as a teacher educator is to prepare teachers for the realities of the job, and to help them create reform oriented science teaching within an organization that imposes considerable constraints on the way teachers go about their work.

I have had the pleasure of working as a teaching assistant in a math and science teacher preparation program since the fall 2010 semester. As a teaching assistant, it is not my role to challenge the approach to teacher education as contained within this program. Thus, in formal classroom situations, I do my best to, for lack of a better term, toe the party line. At the same time, in less formal interactions with students, I am frank in my discussions about teaching in general and my experiences. I am mindful to not discourage preservice teachers from entering teaching. As such, I try to provide them with ideas on how to navigate the demands of public schools in a productive way, drawing on my own negative experiences and reframing them as learning opportunities that I can pass on to preservice teachers.

The confrontation with my administrator continues to shape my research as well. As part of the broader community of teacher educators, I am part of a dialogue on research on teacher education and the transition from preservice teacher to student teacher to novice teacher. My program of research seeks to understand goal systems of science teachers along with the influences on the creation of, commitment to, modification of, and disengagement from cognitive policies that make up their goal systems. It is my commitment that via better understanding of the ways teachers negotiate these demands, we can help prepare preservice teachers to more effectively confront these demands.

Chapter 4: Findings

Understanding why science teachers "do what they do when they teach science" (Tobin & McRobbie, 1999, p. 215) remains an enduring question for the science education community. In chapter two I presented a superordinate theory of cognition, and reviewed the extensive literature regarding the role of both mediating states and environmental states on teacher practice, while also recognizing the paucity of research focusing specifically on goals as a separate and influential piece to the cognitive puzzle. Chapter three introduced the research questions driving this study; expanded upon current theorizing about goal systems that frames this inquiry; and laid out the methods for both data collection and analysis.

This chapter will provide the findings in response to the overarching research question of: *what are the cognitive policies comprising the goal systems of student teachers as they reflect on and plan for their first year of teaching*? Further, I respond to the subordinate questions regarding (1) changes in the goal systems of each student teacher from January to May and (2) if the student teachers expressed any conflicts between cognitive policies. Specifically, I describe the goal systems of four student teachers—A.C, Zach, Kelly, and Jessie (all pseudonyms)—along with the individual cognitive policies that make up each goal system. I also report on conflicts between cognitive policies both within a goal system and between goal systems.

In this chapter, I detail goal systems related to three domains. First, I detail the goal systems of the four student teachers in relationship to their teacher education program. Next, I detail the goal systems of the four student teachers related to Big

State's systemic reform policy. Finally, I detail the goal systems of the student teachers related to the human dimension of the school organization—in other words, their cognitive policies governing how they work with other members of the school.

Prior to reporting the findings, it is important to recall that this study asked student teachers to reflect upon their cognitive policies for their first year of teaching, and not necessarily those for their student teaching assignment—although, there is likely to be congruence between the two. This was a conscious choice, as much of the literature on student teaching describes the often constraining nature of the cooperating teacher on a student teachers curricular and pedagogical choices (McIntyre, Byrd, & Foxx, 1996). Furthermore, Tori, one of the two clinical faculty who oversee the student teaching seminar, recommended deferring to the cooperating teacher when a student teacher disagreed with their cooperating teacher (Seminar Observation 1). Thus, I chose to focus on the goal systems of student teachers as they plan for and reflect upon their desires for their first teaching assignment.

Also recall that I use the term "goal" in a manner congruent with Markman, Brendl and Kim (2007) where goals are quite specific in terms of their behavioral and temporal scope. In other words, a goal is quite specific about what action needs to occur to satisfy the goal (i.e. a goal specifies a very specific action) and is often active only when there is potential for goal attainment. Thus, in figure 3.1, goals only exist at the lowest level of the hierarchical goal system. In contrast, cognitive policies are more abstract, longer term representations at levels above the goal level in the hierarchy (again, see figure 3.1). In contrasting the two, cognitive policies often broadly describe desired outcomes and behaviors occurring over extended periods of time; goals, on the other hand are going to be highly specific in terms of the action needed to satisfy the goal at the current point in time. The temporal gap between when the interviews occurred (Spring 2014) and when the first year of teaching will begin (Fall of 2014) is such that student teachers are reporting upon their cognitive policies, and not the lowest level goals that they will pursue upon entering the classroom as full time teachers.

In placing this chapter within the guiding theoretical framework, recall for hierarchical goal systems, there exists a means/ends relationship between the cognitive policies within the hierarchy. When a cognitive policy is superordinate to a second, lower level cognitive policy, the higher cognitive policy is an end state that the student teacher would like to achieve, while the lower cognitive policy is a means towards the achievement of the higher cognitive policy. In more complex goal systems (i.e. A.C., figure 4.1 and 4.2, respectively) a single cognitive policy can serve as both a superordinate cognitive policy to a lower level cognitive policy and a subordinate cognitive policy to higher levels.

The remainder of the chapter is arranged as follows: first, I provide an introduction to each theme, pointing out commonalities and patterns—or, in other words the answers to the research questions—that emerged across the goal systems of each student teacher. I then detail the goal systems of the student teachers one at a time—first A.C., then Zach, Kelly, and finally, Jessie. In detailing the goal system for each theme, I report the structure of their goal systems at the beginning of the semester and end of the semester, with a brief analysis of each student teachers goal system and highlighting instances of the common patterns across each student teacher. Finally, I report on goal conflicts for each student teacher if and only if they themselves suggested a potential conflict between two cognitive policies within their goal systems. When no conflict is expressed by the student teachers—despite the potential appearance of a conflict to the reader—no conflict is reported.

Goal Systems in Response to Teacher Education

This theme examines the structure of, changes in, and potential conflict within the goal systems related to the pedagogical approaches emphasized in the BSU teacher education program. There is much debate on the effectiveness of teacher education, particularly with regards to classroom implementation of pedagogical practices emphasized in teacher education (Anderson & Stillman, 2013; Brouwer & Korthagen, 2005; Fletcher & Luft, 2011; Kennedy, 2005; Luft & Roehrig, 2007). These questions are important, yet are often based upon an assumption that mediating states and environments are wholly responsible for the practice of teachers. In other words, if teachers have knowledge of and belief in reform-oriented pedagogy and work in schools supportive of this kind of pedagogical approach, they should teach via the methods they self-report they believe in. When observations of a teachers classroom practices do not appear to reflect their stated beliefs, multiple researchers have suggested the belief-practice inconsistency is a result of teachers misreporting their own beliefs (Gill & Hoffman, 2009; Kagan, 1990).

This study proposes an additional reason for the existence of the belief-practice inconsistency mentioned above. The stand taken in this study is that the belief-practice inconsistency may also result from a lack of belief-goal consistency. In other words, in order to understand what teachers do and why they do it (Tobin & McRobbie, 1999), we need to examine the goals systems of teachers. Do novice teachers translate the curriculum of teacher education into cognitive policies? Thus, this theme examines this part of the equation with respect to teacher education: what are the goal systems of student teachers in respect to the curriculum of their teacher education program?

Three main patterns emerged regarding the goal systems of the student teachers changes each student teacher underwent between January and May. The first pattern—in response to the main research question—that emerges from the set of goal systems is that while each student teacher expressed cognitive policies reflective of many of the pedagogical approaches advocated in BSU's teacher education program, they do not expresses all of the pedagogical approaches they learned about as cognitive policies. For example, the 5E model (BSCS, 2006) is the most emphasized curricular framework in the BSU teacher education program. Yet, only Zach and Kelly expressed both knowledge of and a cognitive policy supporting the 5E model into their goal systems. By the end of the semester, Zach appeared to disengage from this cognitive policy.

Furthermore, A.C. and Jessie did not express a cognitive policy reflective of the 5E model during any of our conversations. It is important to note that this does not mean they did not have knowledge of the model or a belief in its applicability and effectiveness in a classroom. In our conversations, it was clear that they had learned about the 5E model, as was evidenced by their ability to describe the model to me. Furthermore, at no point did they suggest that the 5E model was, to any degree, an ineffective approach to teaching and learning. What this means is we cannot conflate lack of a cognitive policy surrounding the 5E model with a lack of knowledge of or belief in the model.

The second pattern, in response to the question of the changes in the goal systems from the beginning to the end of the semester, was that student teachers more frequently disengaged from and dropped a cognitive policy from their hierarchy than they created a new cognitive policy that was subsequently added to their goal hierarchy. All four participants dropped from their goal hierarchies cognitive policies reflective of pedagogical approaches emphasized in the BSU teacher education program. At the same time, only Jessie and Zach added a cognitive policy reflective of their teacher education curriculum. Of note is that they both added the cognitive policy of making content relevant—thus making the cognitive policy of making content relevant the only cognitive policy that all four student teachers expressed a commitment to during the course of the study.

The third pattern, again in response to the question of the changes in goal systems, is that the relationship of cognitive policies within the hierarchy remained in flux throughout the student teaching semester. This was evident in two ways. One way that these changes occurred is through a lower level cognitive policy moving between branches of their hierarchy. For example, in both January and May, Zach held a cognitive policy supportive of the 5E model. In January, the 5E model was a means toward achieving an engaging classroom, while in May, it was a means to formative assessment of students. Another way these changes occurred was having a cognitive policy switch levels, thereby changing its means-ends relationship to other cognitive policies. For example, while inquiry was a direct means to A.C.s highest cognitive policy in January, it was subsumed under engaging curriculum in May, with engaging curriculum a direct means to A.C.'s highest cognitive policy.

Finally, with respect to the question about conflicts between cognitive policies, conflict emerged within the goal systems of Zach and Jessie. Both Zach and Jessie experienced conflict between cognitive policies *within* their pedagogical goal systems. The desire to pursue one pedagogical cognitive policy requires the modification of another cognitive policy. Jessie resolves her conflict in a way that suggests future teaching practice that is both supported by the research base and less than ideal. Zach, on the other hand, resolves this conflict via disengagement from one of his cognitive policies.

Below, I detail each student teacher's hierarchy of cognitive policies related to the curriculum of the Big State University (BSU) teacher education program.

A.C.'s goal systems reflective of teacher education

A.C.'s goal system at the beginning of the semester

At the beginning of the student teaching semester, A.C. already held a well-developed and robust goal system, hierarchically arranged with the cognitive policy of helping students at the top of the hierarchy (see figure 4.1). As a means to achieving this overarching cognitive policy, A.C. expressed four distinct branches of cognitive policies. A.C. also expressed additional cognitive policies subsumed under the two branches of formative assessment and engaging his students, respectively. I detail each cognitive policy below.

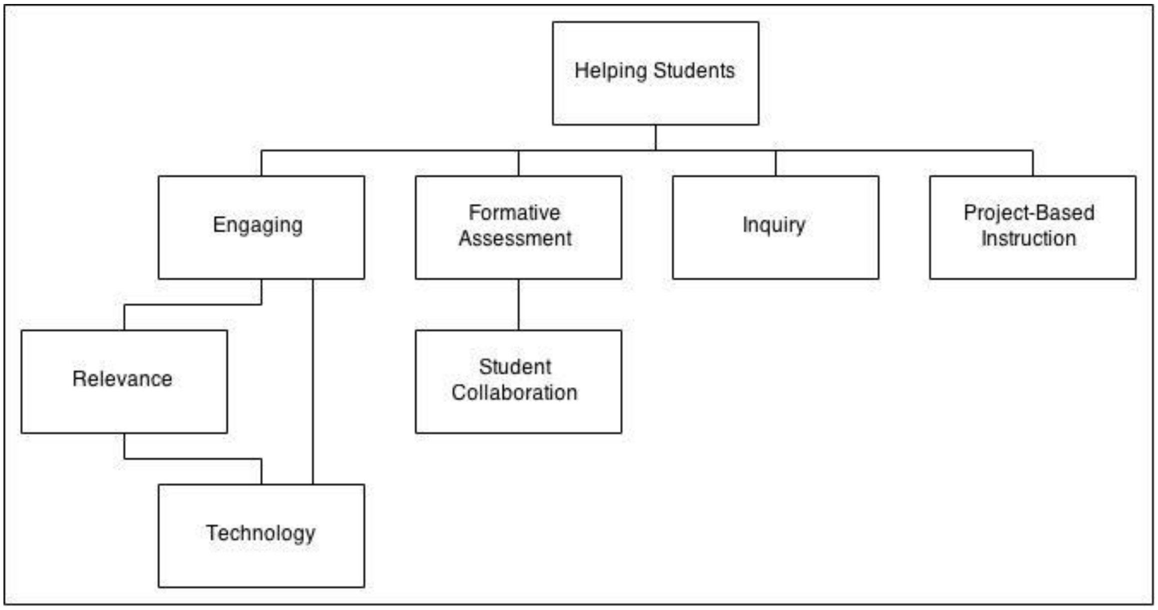

Figure 4.1: A.C.'s Pedagogical Goal System, January

A.C.'s highest level cognitive policy is to be an effective teacher. For A.C., a good teacher is one who helps their students. A.C had always wanted to help others, particularly those in his home town of Border City. He originally came to BSU with the intention of being a pharmacist, but decided to become a science teacher because "you can help so many people being a pharmacist, but seeing students every day and getting a new fresh batch of kids every year. It's like, that's where you can really touch a lot of people" (A.C., Interview 1, pt. 1). His desire to help students was not restricted to those students who had traditionally been successful with school science. As A.C. put it, "to be a really good teacher, you got to take the ones that don't understand and find a way to make them understand" (Interview 1, pt. 1). A.C. wanted to be the teacher to reach those students who had yet to experience in school success.

After taking a few of his teacher education course, A.C. finalized his decision to become a teacher because it provided him an avenue to help young people in Border City, but also because "I really like this [teaching]. Like, I enjoy this" (A.C., Interview 1, pt. 1). A.C. felt this added to his effectiveness in helping his students. A.C. remarked that it is important to be passionate and enthusiastic about what you do, "because if you are not excited to teach, the students aren't going to be excited" and, subsequently, will be reluctant to learn.

At the beginning of his student teaching semester, A.C. had four subordinate branches of cognitive policies that served as a means toward achieving the highest level cognitive policy of being an effective teacher—engaging his students, formative assessment, PBI, and inquiry. A.C. expressed the cognitive policy of engaging his students via enhancing their intrinsic motivation such that they wanted to learn. If students "are more engaged with the lesson, it actually sticks" (A.C., interview 1, pt. 1). He contrasted this with experiences of students in classes that aren't as engaging, leading to students being uncomfortable in class and withdrawing from the learning experience, or "shutting down" as he put it. One way to engage students is via his own enthusiasm toward science. However, A.C. wanted to engage his students via the biology curriculum along with his personality.

Subordinate to the cognitive policy of engaging his students, A.C. expressed a cognitive policy of making content relevant as a means to engage students in his class. In speaking about why it is important to make content relevant, A.C. remarked that relevant content:

> Really reaches out to those kids [students in Border City], making it real, like why it's important. I know a lot of them will be like, "why, mister, why do I got to know this? Why do you got to know that?" Other than, "oh, it's going to be on the test at the end of the year," you got to make it more real for those kids, because honestly, they don't care about no test (A.C. Interview 1, pt. 1).

A.C. realized that for those students who had not been successful previously, appealing to the high stakes state-wide assessment was not sufficient justification for engaging students in learning biology. A.C. would go on to define relevancy as teaching content that was related to "real life," a recurring theme for not only A.C., but for all the student teachers in this study. A.C. would then go on to define real life as pertaining to current events as well as future employment opportunities—both professional (i.e. medical fields) and blue collar (i.e. electricians).

A second avenue to engaging students, as well as a subordinate cognitive policy to relevant content is via the use of technology. First, A.C. felt that having students use and interact with technology in general was more engaging than sitting there watching a teacher lecture. Online simulations also allowed A.C. to transcend resource limitations or safety restrictions, thus engaging students with "explosive demonstrations" if he were to teach chemistry. More importantly, he viewed technology as a vehicle to make content relevant for students. He noted that online simulations "allows you to bring stuff into the classroom that you normally couldn't. Like, if you wanted to show them a tornado or a hurricane" (A.C., interview 1, pt. 2). A.C. also used technology to further connect in-school science to real life via video's from the Ted Talks website. Ted Talks are videos of scientist sharing cutting edge research in ways that are accessible to expert and novice alike. Thus, A.C. was able to have students draw connections between the Ted Talks video and their own lessons.

The second cognitive policy A.C. holds as a means to achieving the highest level cognitive policy of being an effective teacher is the use of formative assessment. "Using formative assessment as a tool to see how effective you are is important" (A.C., Interview 1, pt. 1). For A.C., formative assessment is a measure of his effectiveness as a teacher. Thus, if students are not understanding something, he can adjust his instruction accordingly. A.C. hoped to use formative assessment often to gauge student understanding, because "come [summative] assessment time, that's not when you find out all the students don't know this. You want to know beforehand, so you can correct it, help the students that need help" (interview 1, pt. 1). Formative assessment is a mechanism by which he is able to identify those students who need help.

In support of his cognitive policy of formative assessment, A.C. also held the cognitive policy of student collaboration. He felt student collaboration was a useful means of getting students to share ideas. If student are not collaborating, "how do you really know what they are understanding if you are not hearing what they have to say" (A.C., interview 1, pt. 1). A.C. would highlight his commitment to student collaboration as a means to increase his opportunities for formative assessment. He mentioned using think-pair-share, turn to your neighbor, and the alphabet summary as classroom activities that “require students to collaborate with their peers while all of them increase classroom participation” (A.C. teaching portfolio, 2/1/2014). This then allows him to assess students in a less formal manner before and during a lesson.

The cognitive policy of using Project-Based Instruction (PBI; Barron, et al., 1998; Krajcik & Blumenfeld, 2006) was the third branch subsumed under A.C.’s highest level cognitive policy of helping students. When reflecting upon the PBI approach, A.C. felt it was a “good form of learning, just something different” (Interview 1, pt. 2) from the traditional approach that most students have experienced. He also liked the fact that students were pushed to take responsibility for their own learning. In other words, this allowed him to help students by teaching in a different style, potentially benefiting those students who had not been successful in science previously. However, A.C. did not elaborate much more on the PBI approach, as he felt he still lacked experience planning and teaching through PBI and that he had yet to think of “a good, solid lesson that I want to build it upon” (Interview 1, pt. 2).

A.C. also expressed a fourth branch in the form of the cognitive policy of teaching with inquiry. He stated that he “really wanted to do more inquiry lessons”, and that he felt that inquiry was, like PBI, a different way of learning (A.C., interview 1, pt. 2). He particularly liked that students were able to make their own procedures and form their own ideas about scientific content. A.C. also remarked how inquiry allowed him to challenge his students to refine their ideas and to become more precise with their explanations. Yet, like PBI, A.C. did not elaborate more fully on ways that inquiry could be used to support his desire of helping students.

A.C.'s goal system at the end of the semester

At the end of the semester, A.C. maintained the overarching cognitive policy of helping his students (see figure 4.2), albeit via a more streamlined hierarchical arrangement of his cognitive policies. The two cognitive policies of formative assessment and engagement once again were expressed as means to achieving the highest level cognitive policy. Finally, the cognitive policies of PBI and inquiry were subsumed under the engagement branch. I detail each cognitive policy below.

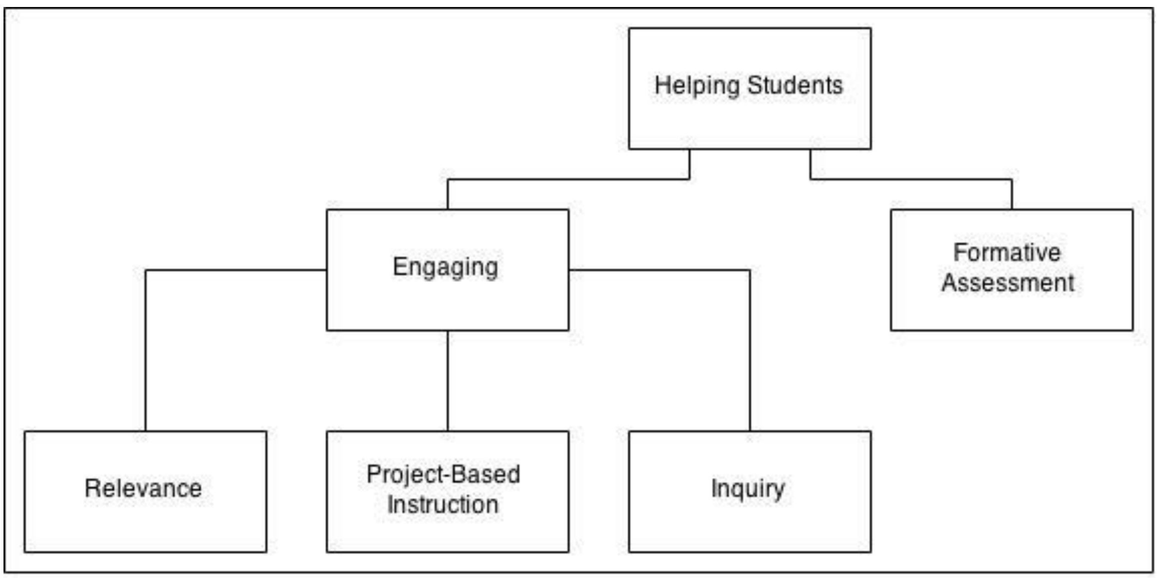

Figure 4.2: A.C.'s Pedagogical Goal System, May

Similar to his goal system at the beginning of the semester, A.C's hierarchy at the end of the semester reflected an overarching cognitive policy of being a good teacher and helping his students. In his teaching philosophy, A.C (April, 2014) wrote:

> I believe the world needs more teachers who are not only masters of the content they are teaching but passionate about it as well. This has been a major reason why I want to be a teacher. I want to have an impact on students and inspire them.

A.C. maintains throughout the semester that his primary motivation is to help and inspire his students.

Similar to the beginning of the semester, A.C. also held a subordinate cognitive policy of engaging students as a means to being a good teacher. “What makes a lesson good,” A.C. (Interview 3) asked rhetorically, answering that “for sure, it has to be engaging because if you don’t have the students’ attention, they’re not going to learn anything” (Interview 3). He continued that to be “an effective teacher, [A.C.] would try and make the content that [he] was teaching interesting” (A.C., Interview 3).

As a means toward engaging students, and making content interesting A.C. continued to hold the subordinate cognitive policy of making science content relevant. In almost identical language from our first interview, A.C. justified the need for relevant content in relationship to high stakes standardized tests:

> The material itself has to be relevant to the students. You have to find ways to make it relevant to them. “Why am I learning this, besides ‘hey, you have to take a test at the end of the year’?” Try to make things relevant to them. Give them real-world examples, maybe an article in the news that you can find or video if possible. Just make it real for them. That’s always what I try to do (A.C., Interview 3).

A.C. further refined this point by rhetorically asking:

> Why do I want you to know this? Because we are dealing with this today, this is what’s going on in the world as we speak. Not just because you’re going to be

asked at the end of the year what does mitochondria do. You need to know why this is important (Interview 3).

A.C. would provide examples of what relevant curriculum is, such as current debates over the policy response to global warming.

While expanding upon his cognitive policy of making content relevant, A.C. would hint at notions of equity and scientific literacy. In other words, A.C. spoke about relevance in ways that are congruent with equitable instruction and promoting scientific literacy, without specifically labeling these ideas in those terms. In relation to making content relevant to increase student learning, A.C. mentioned that "all students need to learn science, whether it be the low-achieving students, the middle-achieving students, or the high achieving students" (A.C., Interview 3), because all students need to have "some understanding of the world around them" (A.C., interview 3). This understanding was important to help students "think scientifically when [they] read certain articles or something's presented in the newspaper. If you don't have any type of background in that material, you kind of overlook and you don't really understand what's being presented" (A.C., Interview 3). Unfortunately, these two notions—equity and scientific literacy—went largely undeveloped in the remainder of our conversation. The way A.C. talks about these two notions, it is difficult to ascertain if these are cognitive policies in and of themselves, or if they are knowledge and beliefs regarding what makes content relevant.

The second cognitive policy that serves as a means to engage his students is that of PBI. Unlike in January where PBI was a direct means toward helping students, in May this cognitive policy was subsumed under the cognitive policy of relevant instruction.

A.C. stated his support for PBI, albeit with the minor qualification related to his inexperience:

> The project-based instruction, or the project-based lessons that I've done—and I've done like two or three—students have always gone beyond. Because they're so engaged in the project that once I started giving them the material, they usually go beyond what you're grading them on the rubric (A.C., Interview 3).

The structure of PBI lent itself to covering broad topics that allowed students to explore scientific content in ways that interested them. A.C. would mention how PBI encouraged "each student to do something different" (Interview 3), and during the presentation phase of a PBI unit, students are able to collaborate, thereby covering a "whole spectrum of what it is you're talking about" (Interview 3). Students are then engaged in learning a broad range of content, as the PBI unit gives students both the freedom to pursue avenues that interest them and the structure to share their discoveries with their peers.

The final cognitive policy in support of making his class engaging is to use the inquiry approach to teaching. Similar to the movement of PBI over the course of the student teaching semester, the cognitive policy of inquiry instruction was subsumed underneath the cognitive policy of making science engaging. A.C. would like to use "inquiry lessons whenever possible just because I think one, they're more engaging, and two, I just feel you learn more from them" (Interview 3), when compared to traditional lecture based teaching. A.C. also liked inquiry because he felt it was particularly engaging with students who are identified as "low –achieving" by the school. He justified this claim via an example from his student teaching semester, where he found that his honors class students were resistant to inquiry and wanted A.C. to "tell [them] what to do so that [they] can do it and finish" (Interview 3) whereas his regular students jumped in and explored.

The second branch of A.C.'s hierarchy has the cognitive policy of formative assessment. In both our final interview and throughout his teaching portfolio, A.C. mentioned the importance of formative assessment for increasing his effectiveness as a teacher. In the portfolio, A.C. remarked that formative assessment provided him with information he could use to "improve the learning experience" of his students. He elaborated on this in our final interview when he stated that, if using formative assessment he realized "only 30% of the class gets it, then obviously you didn't cover the material in a way that's beneficial to the students" (A.C., Interview 3). A.C. also hoped to use formative assessment as a way to pre-test students, gaining valuable insight into their prior knowledge and any possible misconceptions they may hold.

Analysis of A.C.'s goal systems

A.C. provides evidence for the three patterns mentioned previously. With respect to the first pattern, A.C. expressed several cognitive policies reflective of the curriculum of BSU's teacher education program. Inquiry, relevance, formative assessment, PBI, and engaging curriculum are all emphasized heavily in the BSU teacher education program. Interestingly, at no point did A.C. mention a cognitive policy reflective of the 5E model—the most emphasized concept in the BSU teacher education program. This does not mean he lacks knowledge of or belief in the model, only that he does not express the 5E model as part of his goal system.

With respect to the second pattern, while A.C. did not add any cognitive policies to his goal system between January and May, he did disengage from the cognitive policies of technology and student collaboration. Again, this does not mean that A.C. does not believe in these as important, or beneficial to students. Nor does it mean that he "forgot" about them. What it means is, for the same interview protocol, in January A.C. expressed the cognitive policies of technology and student collaboration while in May he did not.

The movement of A.C.'s cognitive policies of PBI and inquiry are indicative of the third pattern. A.C. had the cognitive policies of PBI and Inquiry directly tied to the overarching cognitive policy of helping his students in January. In May, these two cognitive policies were subsumed under the engagement branch of his hierarchy. While A.C. did not drop these two cognitive policies over the course of the semester, their relationship to the overarching cognitive policy of helping students did change. Whereas in January A.C. expressed these cognitive policies as a direct means to helping students, in May these cognitive policies were means to an intermediate cognitive policy—engaging students.

Zach's goal systems reflective of teacher education

Zach's goal system at the beginning of the semester

At the beginning of the semester, Zach had two independent hierarchical branches (see figure 4.3)—one with engagement and enjoyment at the top, and a second branch capped by formative assessment. Each cognitive policy was superordinate to lower level cognitive policies. Furthermore, Zach did not express an overarching cognitive policy that subsumed engagement/enjoyment and formative assessment. In other words, when speaking about engagement and enjoyment or formative assessment, Zach did not make statements indicating that these cognitive policies were subordinate to a higher level cognitive policy. I now detail each of these two hierarchies.

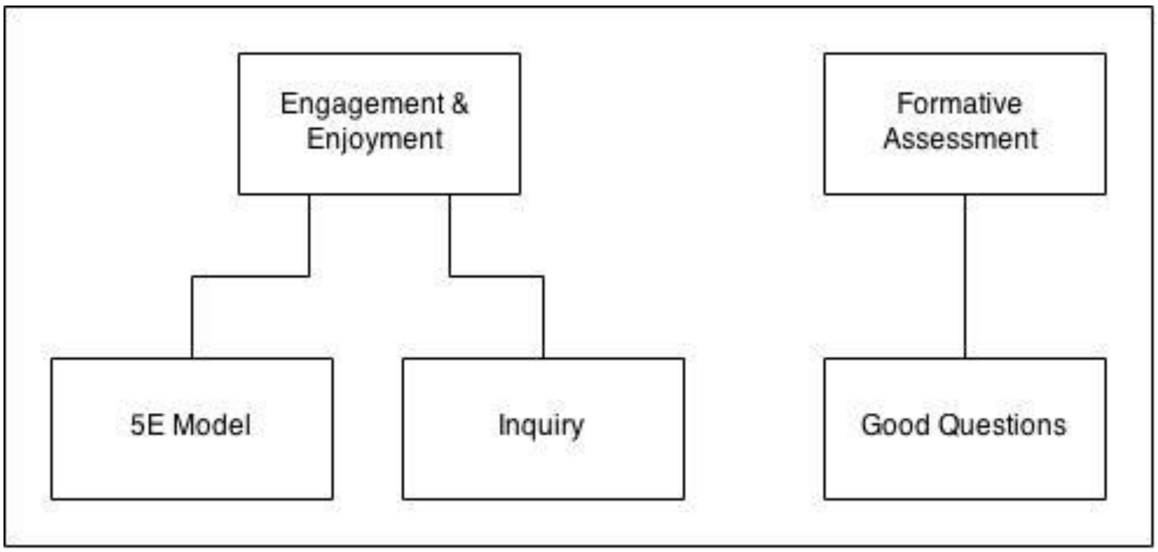

Figure 4.3: Zach's Pedagogical Goal System, January

When speaking about his approach to teaching science, Zach consistently brought up that he wanted his class to be enjoyable and engaging. He would recall from his own experiences that exciting and enjoying curricular approaches made a difference in his own learning. He reflected on the fact that his own teachers, specifically his Physics and AP Chemistry teachers, had made science enjoyable in the classroom, and that influenced his own decision to pursue science as an undergraduate at BSU. In thinking about his desire to create similar classroom experiences for his students, Zach stated that he hopes his students take work from class and “hang it up on their fridge. [Or], they talk to someone. If they talk about my class outside of the classroom that would be really cool” (Zach, Interview 1). He would further elaborate that he wanted it not just to be that he was a nice or fun teacher, but that what they talked to others about was “cool educationally” (Zach, Interview 1). Zach wanted his class to awe and inspire his students.

Zach identifies the 5E instructional model and inquiry as a means to achieving the cognitive policy of creating an enjoyable and engaging experience for his students. In other words, the higher level cognitive policy of enjoyment for his students relies upon the lower level cognitive policies of 5E teaching and inquiry. For Zach, one of the key advantages of the 5E model is the engagement stage, as it is important to “engage students, even if they don’t want to be there, you just have to try” (Interview 1). Zach would suggest that the engage does not necessarily need to tie directly into the lesson for the day—a stance that is incongruent with the stated purpose of the engage step according to the authors of the 5E model (Bybee, et al., 2006). When asked to think about his future classroom, Zach planned to start each day with some sort of engagement activity, in an effort to “bring them back in” (Interview 1). Again, this did not necessarily need to align with the main topic of the day, but instead serves to engage them and increase their enjoyment of his class.

This is not to say that Zach did not reflect upon the engage portion of the 5E model in ways that are congruent with the cyclical nature of the approach. For Zach, one of the biggest advantages of the 5E model is having students return to the engagement and apply their new scientific knowledge to a problem or event. As he described it, “maybe they [students] didn’t quite understand what was going on in the very beginning…by the end of the lesson…they are like, ‘oh, I get that’” (Zach, Interview 1). When speaking about the engagement in this way, Zach also drew connections between this stage and the explain and explore stages of the 5E model, albeit briefly. One of the few examples of this was when speaking about the relationship between the stages, Zach mentioned that students would “have to go into explaining what did you do, or why did it work, why didn’t it work, what could you do to improve it” (Interview 1).

Zach did not, however, view these two purposes—engagement as he described it above and engagement as defined by Bybee and colleagues (2006)—as functionally equivalent. In other words, if and when the engagement stage was able to tie into the broader lesson structure, then he was willing to implement the 5E approach with a higher degree of fidelity. Yet, the connection between the engagement and the other stages of the model was dwarfed by the desire to engage students for their enjoyment purposes.

The second cognitive policy that Zach adopted as a means to creating an exciting and enjoyable classroom environment is that of inquiry. One of the main draws with inquiry is that, compared to a lecture approach, Zach felt inquiry allows students to “be active” in the classroom (Interview 1). For Zach, being active in some way guards against the tendency for students to lose focus. In using his own experience as an example, Zach would state that once he lost focus, he was unable to refocus his attention on learning, and that the “rest of the class was a waste” (Interview 1). This is congruent with the desire to make class enjoyable. The more exciting and enjoyable the class is, the easier it is to keep students attention.

Zach also noted that along with, or as a result of, the enhanced focus of his students, inquiry also led to increased learning for students. In justifying his use of inquiry, Zach drew from his experience as a teaching assistant for an undergraduate course. The course was inquiry based, and Zach recalled that "how the students learned there, they understand it a lot better than if those…students had done a lecture class" (Zach, Interview 1). In light of this, Zach was unequivocal that he "strongly agree[s] with inquiry based teaching compared to lecturing all the time" (Interview 1).

Finally, Zach had a second goal hierarchy related to formative assessment that did not appear to be connected to his desire to make science exciting and enjoyable. Formative assessment was a tool to gauge if students understood the content from both the current days lesson, and the previous days lesson. This would allow Zach to have a better idea of "where they [his students] were at" with regards to their progress within each unit. Supporting the cognitive policy of using formative assessment was a subordinate cognitive policy of asking good questions. Zach felt that by posing good questions to the class, he could generate student discussion that would serve as a formative check-point. Thus, he dedicated much effort to improving his questioning practices, including asking thoughtful, open ended questions and managing the interaction of students in response to his questions.

Zach's goal conflict at the beginning of the semester

At the beginning of the semester, Zach experienced a single conflict within his pedagogical goal system. In an ideal world, Zach would be a biology teacher, as his major at Big State is biology. Yet, Zach recognized that he may prefer to teach chemistry “because I strongly agree with like inquiry based teaching, compared to lecturing all the time and I still have not figured out how to really do biology in an inquiry [approach]” (interview 1). Zach further mentioned that he “hasn’t seen any inquiry in biology, so I just don’t know how to do it” (interview 1). Chemistry, according to Zach, is an easier subject to teach via an inquiry approach. Thus, Zach was willing to modify his pursuit of becoming a biology teacher in an effort to ensure that he would be an effective teacher who used inquiry in the classroom.

Zach’s goal system at the end of the semester

By the end of the semester, Zach’s goal system had undergone major changes (see figure 4.4), including the movement of many cognitive policies within his goal system, disengagement from the 5E model, and the addition of two cognitive policies. Yet, despite the major changes to lower level cognitive policies, Zach maintained two distinct branches, one with engagement and enjoyment at the top and a second with formative assessment at the top. In support of the cognitive policy of engagement and enjoyment, Zach pursues the cognitive policies of making content relevant and the activity-before-content (ABC; Cavanagh, 2007) approach—both of which are added to his goal system in May. Finally, Zach views inquiry as a means to ABC. The branch with the cognitive policy of formative assessment at the top is supported by lower lever cognitive policies of the 5E model and inquiry below.

When speaking about why he wanted his class to be engaging and enjoyable, Zach stated that “maybe they aren’t interested in it [science] because they never had a good teacher. So now you can have a really exciting, engaging, fun teacher” (Interview

3), which would open the door to students learning. In support of this sentiment, Zach mentioned an example of working with a student during one of his field experiences during the teacher education program. He recalled that “one student that really got into it [his lesson] and I think my [cooperating] teacher was sort of surprised because usually he didn’t” (Zach, Interview 3).

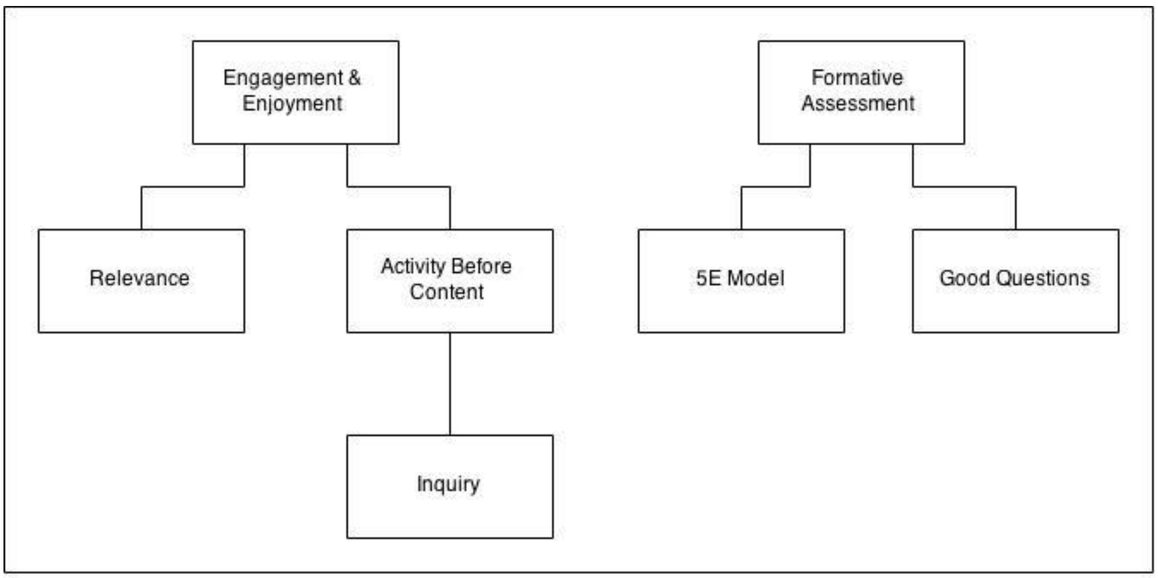

Figure 4.4: Zach’s Pedagogical Goal System, May

Zach further drew upon his apprenticeship of observation when speaking about the importance of engaging students and having them enjoy his class. Zach suggested he was never interested in history until he took AP-US history, at which point he “got into it and…ended up having like the highest score in that class” (Interview 3; also, teaching portfolio). In drawing upon this experience, Zach would project his past self onto his future students, suggesting that he wanted to do the same for those students who did not enjoy science that his history teacher did for him. Without this engaging and enjoyable environment, Zach would remark that “it’s easy to just fall asleep” something he wanted to prevent.

As a means to making the content engaging, Zach wanted to make science relevant. “Having things relevant for students is very important and I can see relevancy in all of the science subjects” (Zach, Interview 3) For Zach, there were two approaches to relevant teaching that he hoped to pursue. The first approach, he called “culturally relevant,” defining culturally relevant teaching as:

> Things that are going on in the world that are school appropriate, things like that. Which, maybe they’ll [his students] find interesting because it’s something that, it’s happening and it’s happening to someone else, maybe someone else of their age, but they don’t even know it (Zach, Interview 3).

Zach felt this was important, because he wanted to expose students to “something outside their bubble” (Interview 3). This approach to relevance was grounded in the belief that he could expand the horizon of his students within the context of science teaching. Science, in this view, is a global phenomenon that provides a gateway for his students to gain further exposure to events and people outside the small community of the school he would teach at the following fall.

It is important to realize that Zach’s use of culturally relevant science teaching differs from that used by Ladson-Billings (1995) and others. For Zach, culturally relevant teaching is using science to expose his students to things outside of, for lack of a better term, their limited cultural exposure. For Ladson-Billings and others, culturally relevant teaching is about grounding teaching in the cultural experience of students and using that as the starting point for instruction.

Zach's second approach for relevance was more focused on his own students, and in some ways, more aligned with the definition of cultural relevance employed by Ladson-Billings (1995). In Zach's own words, he wanted to make his science class relevant:

> So students can tie back their ideas from whatever they're learning to whatever they actually see or do in real life. And now, they have some sort of connection. Now, whenever they think or see about those things, they can actually tie back whatever they learned in class (Zach, Interview 3).

The idea of tying in-school science to out-of-school experiences was very prominent in Zach's thinking, as he would stress this aspect of relevance made science more engaging and enjoyable for students. He also felt that this would become easier as the school year progressed, given that he would get to know his students, and as a result their out-of-school experiences better. The more he knows about his students, the more avenues for Zach to make science relevant to his students.

The second cognitive policy that serves as a means toward making science engaging and enjoyable was the desire to pursue the Activity-Before-Content (ABC; Cavanagh, 2007) approach to science instruction. Zach expressed his commitment to this curricular approach:

> The activity before content things that we learned in [his first teacher education course] is great. Having students figure things out on their own as opposed to,

> again, me lecturing or just looking or reading out of a textbook—which again, is how I did a lot things. I'm good at it [learning via lecture] but it's not fun (Interview 3).

Zach would further elaborate on the cognitive policy to use the ABC approach via an example from his field experiences during teacher education. He remarked that students were excited by the opportunity to explore on their own first, without the need to match their findings to the expectations of the teacher. This allowed for students to take ownership of their own learning, as they learn it first, and turn to Zach to formalize their ideas and bring them in line with the scientific consensus.

As a means to achieving the cognitive policy of ABC, Zach held a subordinate cognitive policy reflecting the advantages of and desire to use inquiry based teaching in his class. In his discussion of inquiry, it is also possible to see how it supports not only ABC, but also his cognitive policy for engaging and enjoyable classroom experiences. "Inquiry…seems to be a really good way of learning because you're getting students engaged and you're getting them to actually think about things as opposed to…just telling you something" (Zach, Interview 3). Adding to the enjoyment and engagement of the inquiry approach is that students also get to do something—a lab—as opposed to sitting there listening to Zach lecture. Zach would state that labs are important because "it's more engaging; you're not just sitting there and I feel like kids are very active" (Interview 3).

In placing inquiry under the ABC approach, Zach also mentioned that part of inquiry is giving students the opportunity to discover and explore on their own. He felt that allowing students to create a procedure allowed them to engage in inquiry while also feeling as if they were engaging in the practices of scientists—an approach that, while not emphasized by the BSU teacher education program, has risen to national prominence with the release of the *Framework for K-12 Science Education* (NRC, 2012). As he put it, students "sort of discover it [scientific knowledge]. This is the process of how they [actual scientists] discover stuff, the same way you [students] did, which is cool. You feel a little bit like you actually accomplished something, which is exciting" (Zach, Interview 3). Again, we see the theme of engagement and enjoyment running through the ABC approach to using inquiry.

Zach also retained the second branch of his goal system, with formative assessment at the top. This hierarchy is important, as formative assessment is one of the few times that Zach would emphasize student learning above other considerations. This is not to say student learning was not important to Zach, only that it often took on a secondary role in the hierarchy with the cognitive policy of engaging students at the top. Formative assessment was important to Zach as it "gives [him] real-time analysis of how the students are doing" (teaching portfolio, 4/5/2014). Formative assessment is important for gauging student progress through a lesson and unit.

Zach further maintained the cognitive policy of using quality questions as a means to formatively assessing students. And, again, he restricted this to orally posed questions—as opposed to other question formats such as two tiered assessments. In this dialogue between Zach and I during out third interview, I am following up on his assertion that he wanted to use formative assessment in the classroom:

> Todd: So, you mentioned something about finding out what they [students] don't know. How do you know what they don't know?
>
> Zach: That's tough. That's like an ongoing process, but really it's just questions. I mean you need to ask them questions in ways that they…have to think through the questions…

Zach would also consistently mention the importance of good questions in his teaching portfolio. One example of the importance of questions from Zach's teaching portfolio is his discussion of prioritizing some questions via a think-pair-share. In Zach's words:

> The reason I felt this would be better is because I think it was a higher level question that may need more time to think about. I didn't want students to say the first thing that came to their mind, instead I wanted them to know that I thought it was important enough to discuss before answering (teaching portfolio, 4/5/2014)

In this statement, Zach is able to express the care he gives to the types of questions he asks. This sentiment was further supported by his cooperating teacher, Mr. Morris, who mentioned that Zach made it explicit that he wanted feedback on ways to improve his questioning in class.

Zach's goal conflict at the end of the semester

At the end of the semester, Zach once again held a conflict between his cognitive policy of teaching through inquiry and his desire to be a biology teacher. In similar statements to those he made in January, in May Zach would indicate that not only is it easier to do inquiry with chemistry, but that "chemistry just seems more engaging" (interview 3). Again, in an ideal world, Zach would resolve this conflict by teaching chemistry.

However, at the end of the semester, Zach came to realize that while he preferred to teach chemistry, he may not be able to find a teaching position that was only chemistry. Thus, disengaging from the goal to teach biology may not be something he is able to do. In that case, Zach mentioned that "when I think of biology labs, I can only think of microscopes and dissections. Otherwise, I feel it would be stations" (interview 3). Station activities were promoted by Tori and Stacy—the two faculty members who oversaw the seminar—as a great way to differentiate instruction for students and to avoid the trappings of a lecture based classroom. If he were to teach biology, Zach modified his cognitive policy of using inquiry by limiting it to certain types of activities, and then substituting the cognitive policy of station activities as a way to teach the remaining content.

Analysis of Zach's goal systems

Zach's goal systems show evidence of the three patterns that emerged during the study. First, Zach held cognitive policies reflective of formative assessment, and inquiry throughout the semester. Both of these are strongly emphasized in the BSU teacher education program. At the same time, Zach does not hold a cognitive policy indicating a desire to use PBI the following fall. This is not because of a lack of knowledge of PBI—not only did Zach take a course on PBI during the BSU teacher education program, but the school Zach student taught as was a "PBI" based school. Instead, Zach made it clear that “most schools aren’t PBI” (Interview 3), and that this approach is likely not to be something he pursues.

With regards to the second pattern, Zach was the only student teacher in this study to add more cognitive policies to their goal system than they dropped—adding the cognitive policies of ABC and relevance between January and May. Zach did drop the cognitive policy of 5E from his hierarchy between January and May. As with his lack of a cognitive policy for PBI, this does not mean that he does not have knowledge of or belief in the 5E model. What it does mean is that he does not prioritize it in such a way as to express it as a cognitive policy to pursue.

Third, Zach’s goal hierarchy remains in flux during the student teaching semester. One of the more notable changes from Zach’s hierarchy is the change in the supporting cognitive policies subsumed under the cognitive policy of engagement and enjoyment. While there is enough overlap that it is difficult to distinguish between the two, Zach’s lower level cognitive policies seem to highlight the enjoyment aspect in January while highlighting the engagement aspect in May. Put another way, in January, Zach hoped his students would enjoy his class because it was fun or “cool” as he put it. By May, Zach wanted his students to enjoy the class due to their engagement with science content and the relevance of the science content to their own lives.

Finally, Zach experienced a conflict between his strong cognitive policy of teaching through inquiry and his desire to teach biology. In January, Zach planned to disengage from his cognitive policy to teach biology, and intends to seek out a teaching position where he only will teach chemistry. By May, Zach had realized a strong possibility of his teaching some biology the following school year. Thus, resolving the conflict via disengagement from his cognitive policy of teaching biology is not a choice afforded to him by the environmental conditions. In response, he modifies his cognitive policy of using inquiry in biology, reducing the amount of inquiry he actually plans to use.

Kelly's goal systems reflective of teacher education

Kelly's goal system at the beginning of the semester

Similar to Zach, Kelly did not indicate an overarching cognitive policy guiding her teaching approach (see figure 4. 5). She has two hierarchical branches capped via the cognitive policies of teaching through the 5E framework and making content relevant, respectively. In turn, these two cognitive policies play a superordinate role to lower level cognitive policies. Also note that the relationship between the cognitive policies of 5E/Engage and 5E/Explore are represented via a dotted line, indicating a tentative link from the 5E cognitive policy for reasons that will be elaborated in the following paragraphs.

At the beginning of the semester, Kelly stated the best approach to teaching Chemistry was through the 5E model. She felt that the 5E model provided advantages to both students and to teachers who use the model. With regards to the advantages the 5E model provides to teachers, Kelly suggested that it structures the curriculum and eases her planning process. At the same time, the 5E model is "an effective method to help students" (Kelly, Interview 1). Because of its ability to make planning easier and to increase student learning, Kelly felt the 5E model was an ideal approach to teaching Chemistry.

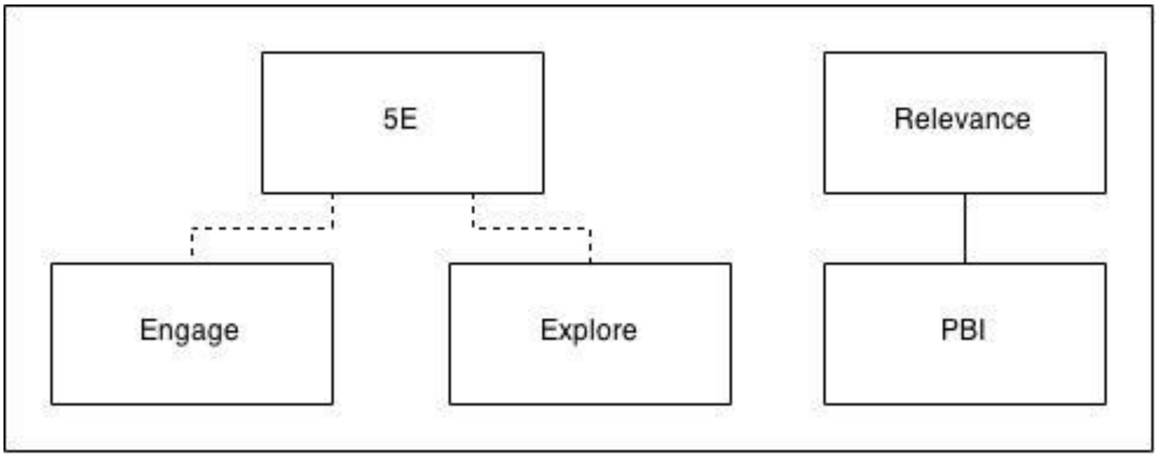

Figure 4.5: Kelly's Pedagogical Goal System, January

Kelly also adopted cognitive policies reflective of two of the five stages of the 5E model. The first stage of the 5E model that Kelly held a cognitive policy for was that of the engagement stage. Kelly would remark that, in order to be an effective teacher of Chemistry, you need to engage students and "captivate them in the subject of Chemistry" (Kelly, Interview 1). Kelly made this point more explicit by mentioning that some teachers attempt to engage students by "jumping on the table" (Interview 1) or "they walk in to class in a pirate costume" (Interview 1). Instead, Kelly hoped to engage students by explicitly engaging them in chemistry, and "having conversations with students and getting them to think a little more critically" (Kelly, Interview 1). In other words, Kelly hoped to engage students in Chemistry, as opposed to engaging them in her personality or some outrageous action.

The second stage of the 5E model that Kelly had developed cognitive policies around was the explore stage. Kelly metaphorically described the explore stage as "exploring a cave, in a way. You don't really know where you are going, but you want to find out what's at the end of the tunnel" (Kelly, Interview 1). In this metaphor, Kelly serves as "a voice that guides them, but does not tell them directly" where to go (Kelly, Interview 1). Kelly also contrasted having students explore with the traditional lecture based approach:

> Throughout [BSU's teacher education program] I have learned that you can try and lecture all you want to students, but for most students, it just goes in one ear and out the other. So, just trying to explore with them. That will be what I am trying to do, and hopefully they will explore with me (Kelly, Interview 1).

Finally, when asked to elaborate on what exactly exploring is, Kelly suggested that "it would be an activity, it would be a lab, it could be a game, it could even be a worksheet" (Kelly, Interview 1), and that the key to the explore is that whatever the activity is, it gets students to "ask questions, get them to ask, well, why is this happening? Let's find out" (Kelly, Interview 1).

Regarding the branch of Kelly's goal system with the 5E model at the top, it is not clear that the cognitive policies of engaging students and having student explore are viewed as subordinate to the higher level cognitive policy. In other words, Kelly did not indicate that engaging and exploring are means to achieving the higher level cognitive policy of using the 5E model. Thus, there is some question as to if the cognitive policies of engaging and exploring are independent cognitive policies or if they are, in fact, subsumed under the 5E model. As described by the authors, however, the 5E model as a whole is superordinate to engaging and exploring (Bybee, et al., 2006). Thus, I have chosen to place engaging and exploring underneath the cognitive policy of 5E teaching while representing this relationship via the dotted line, as opposed to the solid line used to represent other relationships in the goal systems.

The second hierarchy in Kelly's goal system begins with the cognitive policy of making content relevant at the top. She recalled one of the instructors from the BSU teacher education program imploring students to "ask yourself the 'so what' question" (Kelly, Interview 1) for every lesson. By this, Kelly meant that each lesson should be relevant such that she can justify to her students why learning this piece of Chemistry is important. Kelly mentioned several relevant topics that are related to chemistry, from environmental issues, to nuclear power, to the relationship between drinking lemonade and subsequently needing to take an ant-acid. And, in order to pass the "so what" test, she hoped to make "those connections everyday" (Kelly, Interview 1).

Supporting her cognitive policy of relevance, Kelly felt that the PBI approach was particularly beneficial. Kelly liked the PBI approach because:

> It kind of forces you, in a way, to take a concept and apply it to real life and think on a broader spectrum, how does this apply? What does what you are learning have to do with it [real life] (Interview 1).

Kelly would go on to describe the ways that making content through relevance helped students to have a more realistic view of Chemistry. She mentioned that instead of students viewing Chemistry as a list of facts and topics, they were able to have a broader landscape where content is connected to each other as well as to real life. The ability to connect a PBI unit to real life leads to increased student learning, and as such, Kelly plans to use PBI quite extensively in her future classrooms.

Kelly's goal system at the end of the semester

By the end of the semester, Kelly's goal system had become fully hierarchical, with a superordinate cognitive policy of engaging her students through relevant curriculum (Figure 4.6). Subordinate to this are the cognitive policies of using the 5E model and PBI. Also note that at the beginning of the semester, engagement was a potential means to implementing the 5E model, while at the end of the semester, the 5E model is a means to engaging students.. I detail each cognitive policy in Kelly's hierarchy below.

At the top of the hierarchy, Kelly desires to engage her students. When asked what makes a chemistry teacher effective, she responded that "student engagement will tell you what's successful" (Kelly, Interview 1). For Kelly, a means to engaging students is making content relevant. In her own words, in "chemistry, you have to be able to captivate them first and let them understand the relevance, and from there, pull them deeper into all the other objectives we have to learn" (Kelly, Interview 3). Kelly would further elaborate that:

> You have to discuss relevance first. Like, what you are learning, how it's relevant to [students] before you can expand anymore. I feel the students need to have an interest in what they're learning first to hold them down before you expand any deeper (Kelly, Interview 3).

Kelly would go on to list topics that make chemistry relevant, from health and biochemistry to the role physical and analytical chemistry play in modern technology. Finally, she mentioned that relevant curriculum also played off student interests, such that a student with artistic inclinations may enjoy lessons where they can express their creativity.

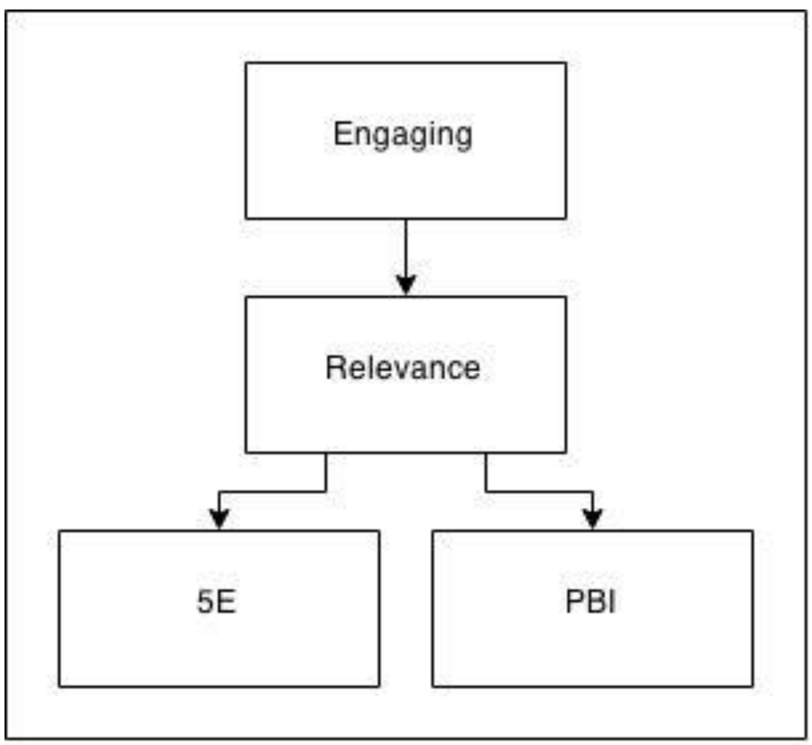

Figure 4.6: Kelly's Pedagogical Goal System, May

Kelly held two subordinate cognitive policies that serves as a means to making chemistry relevant—the curriculum frameworks of the 5E model and PBI, respectively. With regards to her cognitive policy reflecting the 5E model, Kelly felt that “when you work with the 5E’s you are just allowing the material to connect with [students]” (Interview 3). While she felt that all of the stages in the 5E model would provide some opportunity for making chemistry relevant, Kelly felt the engagement stage provided the most utility. In describing how she uses the 5E model, Kelly remarked that to start, “you do something engaging, something that will help them see the relevance in their life” (Kelly, Interview 3). Kelly used the 5E model as a framework to guide her planning and aid in her engaging students through relevant curriculum.

Kelly expressed her cognitive policy of using the PBI model in terms of how it aids her in realizing her cognitive policy of making content relevant. She mentioned that PBI allows her to take her teaching “outside the norms of what [students] are exposed to in the classroom” (Kelly, Interview 3). She elaborated that “with those connections and those real life applications…and all of these different things that [students] are doing that’s out of the norm, they can remember it for just a long period of time rather than just memorizing for the test” (Kelly, Interview 3). Kelly would reiterate that PBI “served as a really good basis for long term comprehension” (Interview 3) because, among other things, students were able to make connections to the real world. For Kelly, PBI is a gateway to making content relevant, and as a result, students learn better.

Analysis of Kelly's goal systems

Again, when examining the development of Kelly's pedagogical goal system over the course of the student teaching semester, we see the presence of the three patterns. First, Kelly maintains cognitive policies throughout the student teaching semester reflective of 5E and PBI, the two curricular frameworks that students are exposed to in the BSU teacher education program. At the same time, Kelly did not mention inquiry at all in out interviews. As with A.C. and Zach, this likely is more an issue of not adopting inquiry as part of her goal system, as opposed to having no knowledge of inquiry. Given the priorities of BSU's teacher education program, she is likely to be familiar with the term. Unlike A.C. and Zach, because she did not mention inquiry, I cannot make claims regarding her knowledge of or belief in inquiry—although she is likely to both know about and believe in inquiry.

Evidence for the second pattern is that Kelly dropped the cognitive policy of exploring between January and May. While the explore stage is part of the 5E model, she did not mention this stage as a means to achieving the 5E model in May. In January, however, she was quite explicit in regards to holding a cognitive policy of exploring with students.

Finally, even those cognitive policies that Kelly maintained through the semester remained in flux. For example, in January, the 5E model was an independent branch in Kelly's goal system. By May, Kelly subsumed the branch of the 5E model underneath the cognitive policy of making content relevant.

Jessie's hierarchy reflective of teacher education

Jessie's goal system at the beginning of the semester

Jessie entered the student teaching semester with a disjointed goal system reflective of her teacher education program (see figure 4.7). Along with Kelly and Zach, Jessie did not indicate an overarching cognitive policy guiding her teaching approach. She has three independent branches of cognitive policies—preventing student misconceptions, teaching through PBI, and teaching through inquiry. Of these, preventing misconceptions and inquiry each have a subordinate cognitive policy, while PBI stands on its own. I detail Jessie's cognitive policies below.

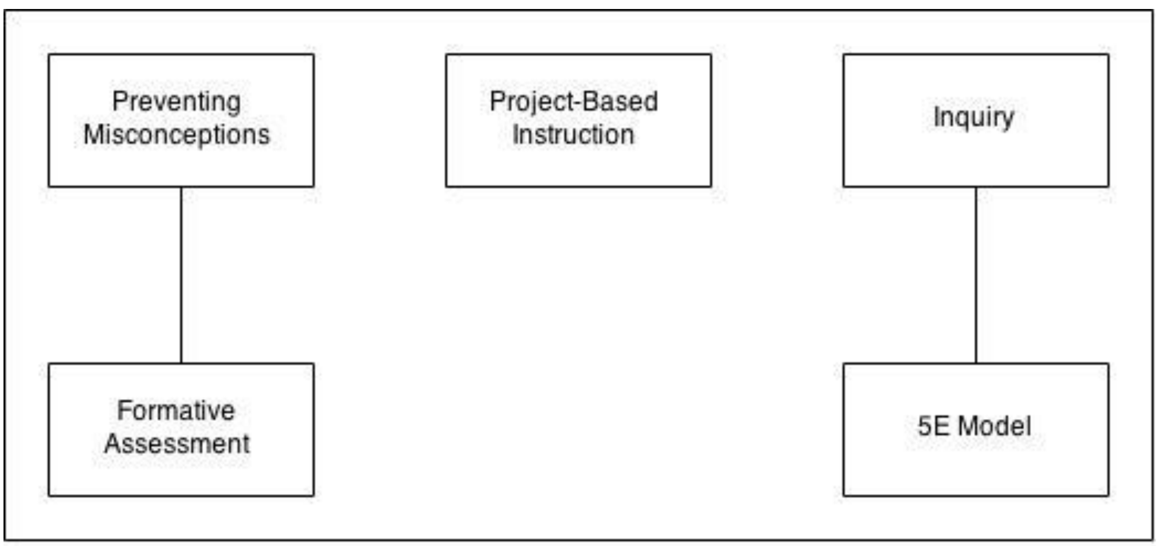

Figure 4.7 Jessie's Pedagogical Goal System, January

Jessie was quite concerned with the possibility of student misconceptions and planned to base many of her instructional decisions upon this. The possibility of student misconceptions was also addressed in her teaching portfolio, where she wrote on the importance of "[ensuring] that there were no content errors or misconceptions present in the students' thinking" (Jessie, teaching portfolio, 3/1/2014). During our first interview, she mentioned the importance of addressing student misconceptions and the influence it had on her overall instructional approach, a topic that we will return to when discussing Jessie's goal conflict in the next subsection.

As a means to identifying student misconceptions, Jessie hoped to give her students formative assessments quite often. She stated that it was important to "monitor student responses, seeing what they think. You know, seeing if they understand the content" (Jessie, Interview 1). Jessie continued that this would allow her to "see every student's needs" (Interview 1) and adjust her instruction accordingly. Formative assessments provided Jessie ample opportunity to identify and address student misconceptions, something that she felt was quite important.

The second cognitive policy that Jessie had during the beginning of the semester was to teach using the PBI approach. In her teaching portfolio (2/1/2014) Jessie wrote that PBI is "a very effective way to implement engaging lessons," and that through PBI, you "encourage student participation, engagement and generation of ideas and products." In our interview, Jessie mentioned that PBI was different from other kinds of instruction that students had been exposed to during their previous science classes, and that this is a more meaningful learning experience for students.

Finally, Jessie had the cognitive policy of using the inquiry approach in her classroom. Jessie liked inquiry because "instead of sitting there and listening to someone talk at them, [students] are using manipulatives, doing an experiment, hands on. They are constructing what they are learning" (Interview 1). Jessie also indicated a preference for inquiry in her portfolio, mentioning many of the advantages that she mentioned for PBI. Jessie felt that inquiry ensures "an engaging environment in which [students] feel free to learn through collaboration" (Interview 1), and again, helps students to "generate ideas" (interview 1). Jessie also mentioned that part of doing inquiry is having students "explore" and "explain"—two stages of the 5E model—but she did not go into further detail on the relationship between inquiry and the 5E approach.

Jessie's goal conflicts at the beginning of the semester

Jessie expressed a goal conflict between her cognitive policy of using inquiry and her cognitive policy of preventing misconceptions. As Jessie described this conflict, "if it's all just inquiry…misconceptions can arise" (interview 1). Jessie further elaborated that "it's harder to keep track of what everyone's doing when it's inquiry. It like, you have 6 groups to keep track of and make sure every single person in each group doesn't have a misconception" (interview 1). Thus, Jessie planned to modify her use of inquiry. In her words "a lot of students don't like that, when it's all inquiry. They like to have some notes to go on. So, kind of a balance between the two [inquiry and lecture]" (interview 3).

What is important to note is that both of these cognitive policies are, in isolation, things that Jessie hoped to use during her first year teaching. Moreover, each of these cognitive policies is based upon a research base that Jessie was exposed to as part of her teacher education program. Yet, the desire to pursue each cognitive policy leads to a conflict when viewed as part of her larger goal system. Jessie resolves this conflict by modifying her cognitive policy to use inquiry in her classroom.

Jessie's goal system at the end of the semester

By the end of the semester, Jessie reduced the size of her goal system stemming from the teacher education program at BSU (see figure 4.8). In May, Jessie had disengaged from three cognitive policies that she held in January—preventing misconceptions, formative assessment, and using the 5E model. At the same time, she did adopt a new cognitive policy of making content relevant for her students. Thus, by the end of the semester, Jessie's goal system was composed of three independent cognitive policies: teaching through inquiry and teaching through PBI are maintained from January, and the third, added cognitive policy of relevant content. I detail the three cognitive policies below.

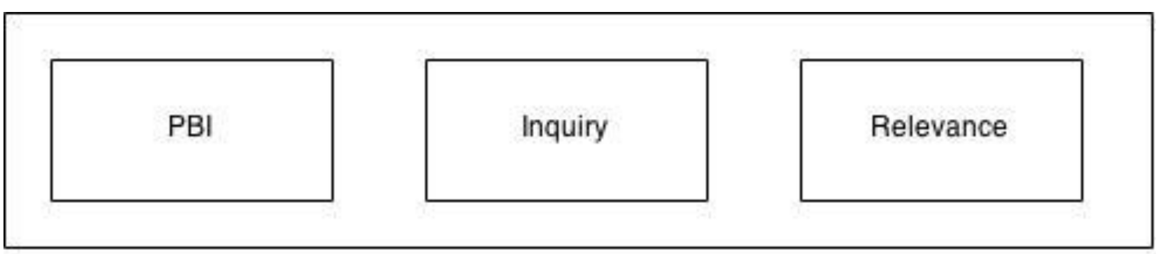

Figure 4.8: Jessie's Pedagogical Goal System, May

The first cognitive policy that Jessie maintained throughout the student teaching semester was PBI. Jessie suggests that PBI is an excellent method for teaching middle school science, and that it "keeps students actively engaged through a lesson and provides an opportunity for students to learn through addressing a problem" (Jessie, Teaching Portfolio, 3/1/2014). Jessie also made it clear that she felt PBI was an appropriate approach for any middle school student, and that while she originally expected to teach 8^{th} grade, her teaching assignment for the following fall was split between 6^{th} and 7^{th} grade. Unfortunately, Jessie did not elaborate on PBI to a greater extent beyond indicating she felt it was beneficial and that she planned to use it in some capacity during her first year of teaching.

The second cognitive policy Jessie holds onto is that of using inquiry approaches in her classroom. When describing her approach to lab instruction, Jessie mentioned that she planned to use the inquiry approach, and that includes "investigation, its hands on. They are following some sort of scientific design processes, like hypothesis testing. Gathering data" (Jessie, Interview 3). She continued that at higher levels of inquiry, her students would "come up with a procedure, like design your own experiment" (Jessie, Interview 3). She maintained that the inquiry approach would also be applicable to any middle school student.

Finally, Jessie adopted a cognitive policy of making science content relevant for her students. Jessie was committed to a vision of relevance that was about using current events as a gateway to learning science content. In thinking about her curricular responsibilities at Magnet Middle School for the coming school year, Jessie was to teach an elective course on content that was beyond the scope of the state standards and district mandated curriculum. The topic of the course was open for teachers, and each teacher was required to explore a new topic each grading period. In thinking about how she would approach this elective course, Jessie stated:

> The first one I'm going to do is about oil spills in [Big State]. Then I might do one—you have to figure out what you are going to do. You have to do four every year. Another one I want to do is like the science of cooking. Kind of like Alton Brown [a Food Network TV personality]. You know how he always describes the chemistry behind what's going on and then actually, get to cook. Stuff like that. (Interview 3).

The oil industry plays a big role in the local economy of where Jessie would be teaching the following fall. Thus, issues of oil production play a role above and beyond the typical treatment from an environmental aspect, but also from an economic aspect as well. Jessie hoped to use oil spills to leverage student engagement with various topics in environmental science, biology, and chemistry.

Analysis of Jessie's goal systems

Like the other student teachers in this study, Jessie exhibited all three patterns as her goal systems developed. First, Jessie held a cognitive policies supportive of inquiry and PBI throughout the student teaching semester. Also of note is Jessie was the only student teacher to hold cognitive policies of the three main pedagogical approaches emphasized in BSU's teacher education program at a single point in time. In January, Jessie held cognitive policies reflective of inquiry, PBI and the 5E model, respectively.

Jessie also disengaged from more cognitive policies than she adopted. Jessie disengaged from the cognitive policies of preventing student misconceptions, using formative assessment and the 5E model between January and May. Jessie did, however, add relevance to her goal system between January and May, thus making relevance the only concept that was a part of all four student teachers goal systems.

Finally, Jessie ended the student teaching semester with both the least number of cognitive policies as well as the least structure amongst them of any of the student teachers in this study. In comparison to the other three student teachers in this study, her goal system became less structured over the course of the semester, as opposed to the other student teachers who saw an increase in the structure of their goal systems.

Finally, in January, Jessie exhibited a conflict between her cognitive policy of using inquiry and preventing misconceptions. Jessie resolved this conflict by modifying her cognitive policy of using inquiry. By May, Jessie no longer held the cognitive policy of preventing misconceptions as part of her goal system. As such, the conflict was resolved via a disengagement from one of her cognitive policies.

GOAL SYSTEMS RELATED TO SYSTEMIC REFORM

In this section, I detail the cognitive policies that govern the student teacher's responses to systemic reform policy. Two features lay at the heart of systemic reform initiatives: content standards and tests to measure the degree with which students have mastered the content standards (Cohen, 1996; Porter, 1989; Smith & O'Day, 1990). Many states have codified systemic reform as part of their accountability policy—policy that also includes graduation rates and teacher evaluation measures, among other elements—as part of holding teachers, schools, and districts accountable for student learning. As such, in these states, accountability policy is a superordinate policy that subsumes systemic reform policy as one of the tenets of this broader policy initiative. However, the day to day practice of science teachers is more affected by the systemic reform component of the broader policy system (Anderson, 2012). As such, the second theme details student teachers' goal systems related to systemic reform policy, as opposed to the broader issue of accountability policy.

Big State has a long history of systemic reform policy as part of a wider accountability movement. The current state wide standardized test—the Big State Big Test (BSBT)—does serve a high stakes role as part of Big State's larger accountability movement. The current incarnation of the BSBT is a new version of, and officially, different from the test each of the participants took while they were in high school. There exist two main differences between the test the participants took in high school and the current manifestation of the BSBT. The first difference is that the current version of the BSBT is given as an end-of-course exam in high school, whereas the test the participants took was given as a summative exam at the end of multiple years. The second difference is that the BSBT distinguishes between "core" and "peripheral" standards.[7] Core standards are more frequently tested on the BSBT and comprise approximately two-thirds of the questions on the BSBT. Peripheral standards are less frequently tested and comprise only one-third of the test questions.

Two patterns emerged from examining the systemic reform related goal systems of the student teachers in this study. The first pattern, in response to the main question, is

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[7] Please note that these are pseudonyms for the distinction used by Big State, in keeping with the anonymity of the state in which this study took place.

that a cognitive policy to teach the BSSS is present in each student teachers' goal system in both January and May. In some cases, the student teachers adopted this cognitive policy as a means to helping their students achieve desirable scores on the BSBT. In other instances, the student teachers adopt this cognitive policy in deference to the authority of Big State to set content standards, and their role as employees in the state wide public school system.

The second pattern to emerge, related to the development of the goal systems from January to May, is when the cognitive policy of having students pass the BSBT was strong, the goal systems of the four student teachers were more hierarchically structured. In other words, given a strong cognitive policy of having students pass the BSBT, there were hierarchical, means/ends relationships between cognitive policies. When the cognitive policy for having students pass the BSBT was either weak (i.e. Zach) or absent (i.e. Kelly in May), the cognitive policies making up this goal system often stood independent of one another. A.C. held a strong cognitive policy of having students pass the BSBT in both January and May, and arranged his other cognitive policies related to systemic reform policy hierarchically in support of this driving cognitive policy. In contrast, for Jessie and Kelly, they both held a stronger cognitive policy for students to have good BSBT scores in January, and subsequently had more structured, hierarchical goal systems. By May, both Jessie and Kelly had accepted teaching jobs at schools where they expected the BSBT to have little or no influence—the case of Jessie and Kelly, respectively—on their classrooms. At the same time, there was an absence of structure to their goal systems in May. And, while Kelly did disengage from the cognitive policy of having her students pass the BSBT, Jessie held onto the cognitive policy but did not have an underlying hierarchical structure with means/ends relationships between her cognitive policies.

Finally, with regards to the question of goal conflicts, A.C., Kelly and Zach all experienced a conflict between their pedagogical goal systems and their cognitive policies related to the systemic reform policy of Big State. Furthermore, these conflicts arose during the semester. They did not express any conflicts between their systemic reform goal systems and their pedagogical goal systems in January. By May, however, A.C. expressed a conflict between his pedagogical goal system and his cognitive policy to have students pass the BSBT. Zach and Kelly expressed a conflict between their pedagogical cognitive policies and the BSSS.

A.C.'s goal systems reflective of accountability policy

A.C.'s goal system at the beginning of the semester

In January, A.C. had a very linear set of cognitive policies related to Big State's systemic reform policy (figure 4.9). At the highest level was a desire to prevent state oversight from entering the school. As a means to realizing the cognitive policy of preventing state oversight, A.C. held a cognitive policy of getting his students to pass the BSBT. Finally, in order to succeed in having good scores on the BSBT, A.C. adopted a cognitive policy of teaching the Big State Science Standards (BSSS), the content standards for Big State. I detail each cognitive policy below.

The highest cognitive policy A.C. holds in relation to systemic reform policy is the desire to help his future school avoid state oversight. A.C. mentioned that schools want good scores on the BSBT so “they don’t fall into that danger zone where the state has to come in” (A.C., Interview 1, pt. 2). By “come in” A.C. meant that state officials “come in and observe and watch” (A.C., Interview 1, pt. 2) what teachers do in the classroom. At worst, the state could potentially take over the school, a possibility A.C. did not fully elaborate upon. Because of this, A.C. recognized that “there is a lot of pressure on teachers to be good at what they do” (Interview 1, pt. 2). Interestingly, A.C. recognized a chain of pressure, where “the principal is putting pressure on them [teachers], but the principal is feeling the pressure from the state” (A.C., Interview 1, pt. 2). For A.C., his cognitive policy is built upon relieving the pressure that his principal places upon him via helping the school as a whole relieve the pressure brought down from the state.

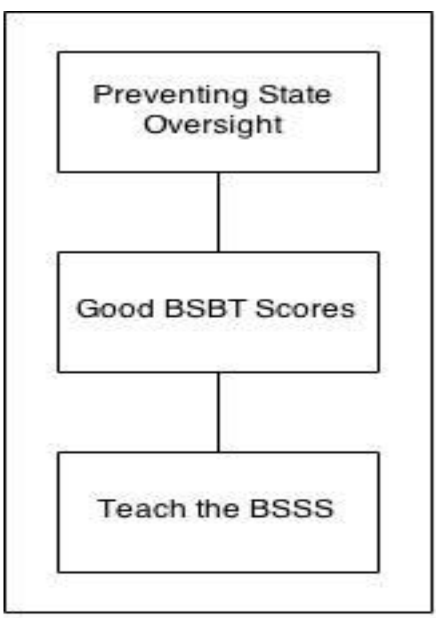

Figure 4.9: A.C.’s Systemic Reform Goal System, January

A.C. adopted a cognitive policy of having his students obtain good scores on the BSBT. This cognitive policy functions as both a means toward the highest level cognitive policy—preventing state involvement in his school—as well as an end that he works toward via the lowest level cognitive policy of teaching the BSSS. Unlike many of his other cognitive policies, A.C.'s description of this cognitive policy is quite limited. Yet, it is clear that it serves as an intermediate cognitive policy between the overarching cognitive policy of the school getting good scores and teaching the BSSS when he states:

> Some standards are held, I guess higher…I forgot the exact terminology that we are using, but this standard they got to pay more attention to it because it's highly tested and it's built upon. Then they have supporting standards, so they are still on the BSSS and you need to teach them, but they are not really [tested] as much (A.C., Interview 1, pt. 1).

Here, A.C. is making it clear that not every standard is of the same level of importance. Furthermore, the importance of each standard is based upon the frequency and likelihood of it being tested on the BSBT. This also mirrors the core/peripheral distinction applied to each of the standards in the BSSS, as well as the frequency with which each standard is tested on the BSBT.

At the lowest level of A.C.'s hierarchy related to systemic reform accountability policy, A.C. felt it important to teach the BSSS. When asked how he would determine what content to teach, A.C. replied that "you first have to go off the [BSSS] standards because at the end of the year they [students] are going to get that exit level exam"

(Interview 1, pt. 1; also teaching portfolio). By exit level, A.C. is referencing the fact that students must pass the biology BSBT in order to graduate from high school. A.C also mentioned that while he would be able to determine the order in which each individual standard was taught to students, he had much less discretion in teaching the BSSS as a whole. “I know they [the BSSS] are posted and I know that’s what we have to cover” (A.C., Interview 1, pt. 1). As an example, A.C. mentioned that despite their order in the list of standards, “you can’t teach protein synthesis without first teaching DNA replication and then teaching transcription” (Interview 1, pt. 1), and contrasted his desire to teach standards in a logical order with other “teachers that go like straight from [standard] one to two to three…” (Interview 1, pt. 1). While A.C. has the freedom to teach content in the order he deems best, the content itself must reflect the BSSS.

A.C’s. goal system at the end of the semester

At the end of the semester, A.C. still held an overarching cognitive policy of responding to and prevention of state pressure related to accountability policy (see figure 4.10). Supporting the cognitive policy of preventing state oversight is the cognitive policy of having students get good scores on the BSBT. This cognitive policy subsumes two lover level cognitive policies: one where A.C. teaches the BSSS and a new cognitive policy regarding data based decision making. I detail each cognitive policy below.

A.C. planned to teach in a school in Border City, and fully expected to be in a situation where schools felt significant pressure from the state to have good test scores. Basing his expectations upon his own experience, A.C. recalled that teachers “were just trying to teach to the test because the scores were so low and they were already borderline getting run by the state" (Interview 3). Thus, he has the cognitive policy of working with the school as a whole to achieve "that [BSBT score] that everybody's trying to shoot for. It's what's necessary for the school to be considered at a level where it can function without the states involvement" (A.C., Interview 3).

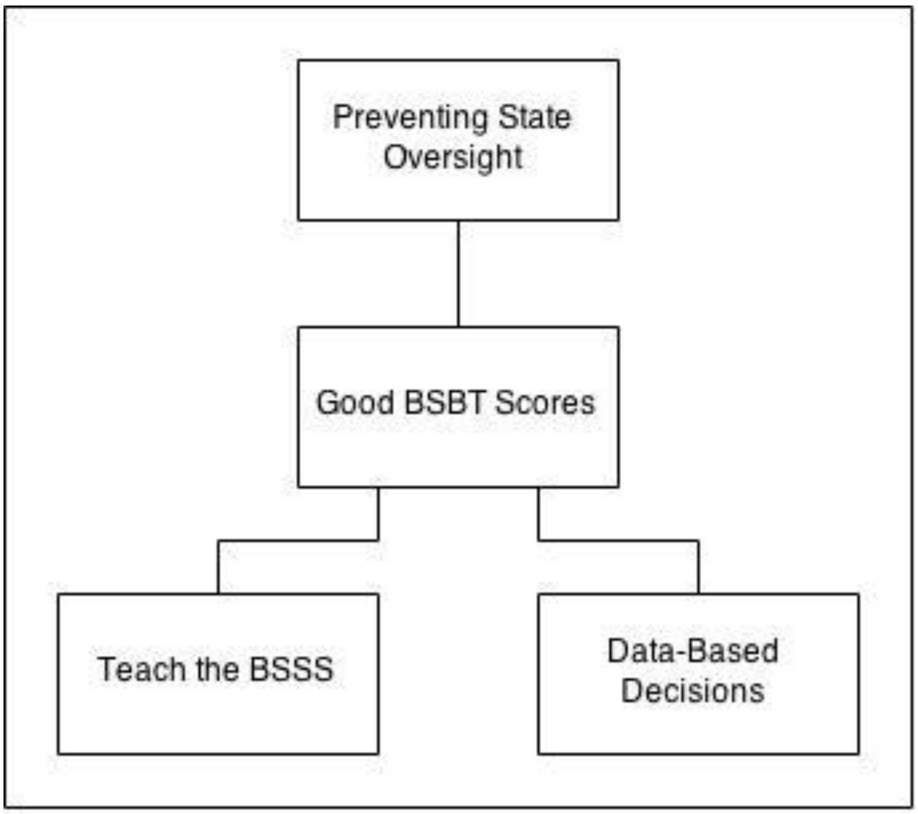

Figure 4.10: A.C.'s Systemic Reform Goal System, May

Unlike the beginning of the semester, where A.C. clearly separates the pressure on schools and teachers from the BSBT, at the end of the semester, the cognitive policies of preventing pressure from the state and getting good test scores became conflated because of A.C.'s prevailing belief that, as he put it, "[Big State] only cares about how well students are doing on the [BSBT]" (Interview 3). In other words, A. C. suggests the cause of state pressure is bad test scores, and if a school gets good test scores, then there is no pressure from the state. A.C. would mention that is it important to mitigate this pressure coming down from higher levels of authority by getting good test scores.

As a means to supporting the school in getting good test scores, A.C. held a subordinate cognitive policy of teaching the BSSS. In a very similar exchange to one we had at the beginning of the semester, when asked how he determines what students need to learn, A.C. responded that "There are the [BSSS]. I mean, of course they need to know that for sure, because they're going to be assessed based on the [BSBT] test. That's content they need to know" (A.C., Interview 3). He would continue that the BSSS represent the minimum biology content that students need to learn, and that "all I know is, I've got to teach them [the BSSS] because they say I've got to" (A.C., Interview 3). The role of the BSSS in A.C.'s classroom remains unchallenged.

Over the course of the student teaching semester, A.C. developed a second cognitive policy that serves as a means to having his students get good test scores and to ward of pressure from the state: using data to make instructional decisions. A.C. adopted this cognitive policy because he agreed with those who think about questions such as "what are we going to do so the students who aren't performing at the level we want them to are able to understand that content before they have to take the BSBT in May" (A.C, Interview 3)? A.C. agrees with the need for some sort of district benchmark test to identify "if students are getting the content that they need to know for the [BSBT]"

(Interview 3). A.C. then suggests that by analyzing data from the benchmark, it is possible to create a “plan of action, so to speak, whether it be tutoring or whether it be students going from class to class and teachers only teaching certain…standards on particular days for certain students” (Interview 3). Thus, A.C. holds the cognitive policy to use data obtained from district benchmarks to aid in his approach to helping his students pass the BSBT.

It is important to note that this lower level cognitive policy also serves as a lower level cognitive policy within another goal hierarchy—namely to work within the school organization and to follow the directives of his administrative team. In other words, the cognitive policy of data based decision making was *supplied to* A.C. by his student teaching school. Further, A.C. expects this to be the case for him next year as well, as evidenced in the following exchange from our final interview:

> Todd: Do you think other schools do that kind of stuff [data based decision making]? Is that a common practice?
>
> A.C.: I’m pretty sure. Because they were always talking about [another school] and other schools, what their performance was on the [district benchmark]. I know for sure they all have to take the same test. And, I’m pretty sure they all do the same thing in looking at the data, looking at where the students are struggling and where they’re not.

While A.C. adopted this cognitive policy, he does it in response to the organizational climate and its congruence with his desire to help students pass the BSBT.

A.C.'s goal conflict at the end of the semester

At the end of the student teaching semester, A.C. experienced a conflict between his pedagogical goal system and his cognitive policy of working with the school to improve student scores on the BSBT. This conflict is particularly acute as A.C. has expressed a desire to teach in schools that have traditionally felt the pressure of state accountability systems the heaviest. A.C. recognizes that many schools feeling this pressure adopt reductionist pedagogical and curricular approaches such as those his own high school adopted (for a definition of reductionist pedagogy, see McNeil & Valenzuela, 2001). In reflecting upon his schooling experience, A.C. mentions that "when I was there, they were just trying to teach to the test because the scores were so low" (interview 3). A.C. is not at all surprised by the "direct impact" that the test scores have and will continue to have on the classroom.

At the same time, A.C. hopes to distance himself from those approaches while still maintaining a focus on getting his students to pass the BSBT. A.C. made this clear when he said that other teachers and administrators are often like:

> "Make sure the students are doing this many [BSBT] questions a day. Make sure students are doing this, doing that." Question taking strategies rather than content knowledge. Rather than understanding, they [other teachers and administrators] are like "well, you know that answer can't be this and this" process of elimination type stuff, kind of bettering their chances [of getting questions right]. Yeah, that's important while taking the test. *But, I think if you know the content, then you won't even have to worry about test-taking strategies* (interview 3).

As is the case for other goal conflicts that are detailed in the section titled "A.C.'s goal systems reflective of the human dimension of the school organization," A.C. is unwilling to modify or disengage from his pedagogical cognitive policies in order to achieve good test scores. A.C. is further of the mind that good teaching will increase the likelihood that his students will pass the BSBT. In an ideal world, A.C. hopes this potential conflict does arise. As we will see in theme three, A.C. also has a plan of action for dealing with the conflict when it does.

Analysis of A.C.'s goal systems

In A.C.'s goal systems, we see evidence of both patterns. First, like all of the student teachers, A.C. held the cognitive policy to teach the BSSS. Both in January and May, A.C. adopted this cognitive policy as a means to having his students do well on the BSBT. While A.C. was aware that the state played a role in the creation of the BSSS, he did not use this knowledge as justification for teaching the BSSS.

The second pattern is that A.C. held a strong desire to have his students pass the BSBT. Given the importance of the BSBT to schools, coupled with his desire to teach biology, A.C. maintained a strong commitment to having his students pass the BSBT biology test. A.C. also maintained a well-developed hierarchical goal system throughout the semester, placing the broad desire to have the school do well at the top.

Finally, A.C. developed a goal conflict with respect to the BSBT between January and May. A.C. felt that the BSBT would potentially interfere with his ability to use the reform-oriented pedagogical approaches that were emphasized in his teacher education program. Furthermore, A.C. expressed an intent to modify his cognitive policies related to the BSBT, as opposed to his pedagogical cognitive policies. This approach would set A.C. apart from Zach and Kelly, who resolved this conflict via a modification of their pedagogical cognitive policies.

Zach's goal system reflective of accountability policy

Zach's goal system at the beginning of the semester

Zach had the least hierarchical goal system related to systemic reform policies of any of the student teachers entering the semester (see figure 4.11). This is not to say that Zach had no cognitive policies related to the high stakes accountability policy, as he held the cognitive policy of teaching the BSSS and, to some extent, having good BSBT scores. What it does suggest, however, is that each of these cognitive policies stood on its own. In other words, Zach did not necessarily see his teaching of the BSSS as a means to achieving good test scores, or vice versa.

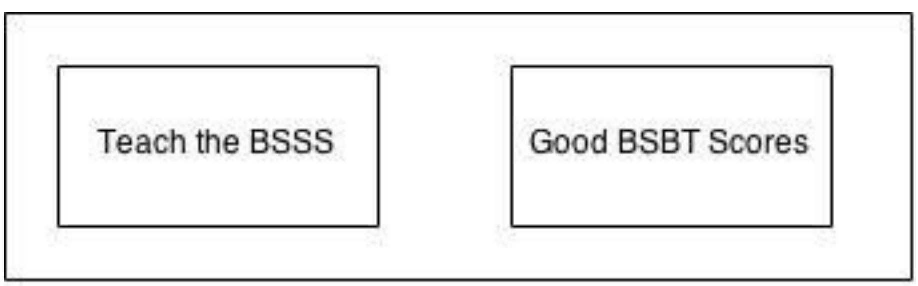

Figure 4.11: Zach's Systemic Reform Goal System, January

The first cognitive policy that Zach held was to teach the BSSS. When asked how he would decide what Chemistry content to teach the following year, Zach replied that “the [BSSS] sort of decide it. You need all of [the BSSS] at least” (Interview 1). At the same time, Zach would elaborate that while his main responsibility was to teach the BSSS, he was able to supplement them with topics outside of the standards. According to Zach, there are topics “in chemistry that aren’t on the BSSS, but if I find it interesting, if I can find time, I think it would be really cool to incorporate it” (Interview 3). In January, Zach’s cognitive policy surrounding the BSSS was to teach the state mandated standards, but not to limit his teaching in response to the standards.

As with the other student teachers in this study, and despite Zach’s cognitive policy to teach the BSSS, Zach was unable to provide any information on what was or was not in the BSSS. When I asked Zach for an example of the content he wanted to teach to supplement the BSSS, he was unable to mention a single topic from chemistry. When I further asked him what general topics are on the BSSS (i.e. atomic theory, gas laws, or conservation of mass), Zach responded that “off hand, I don’t know” (Interview 1). Thus, Zach held a cognitive policy of teaching the BSSS and supplementing them with additional content without knowing what content was or was not actually contained in the state standards.

The second cognitive policy that Zach held related to Big State’s high stakes accountability policy surrounds the BSBT that students are required to take at the end of the school year. When asked why the BSBT was so important, Zach stated “that’s what they have to pass. Like, what’s expected of them” (Interview 1). Zach further elaborated that Big State relies on the scores from the BSBT to determine the effectiveness of the schools within the state. Furthermore, when asked how he thought his school would evaluate him the following school year, after a brief pause, Zach replied "I don't know. Test scores" (Interview 1). Unlike A.C., Zach did not elaborate on approaches that either he or the school would take to increase student test scores. He would recall his own experience in high school:

> I don't really remember them [the precursor tests to the BSBT]. To me, they were just…they were the easiest things ever compared to like AP classes. We would zoom through those [the precursor tests] and then couldn't do anything else for the rest of the day. I can't even remember if you are allowed to bring a book [to read when he finished] (Interview 1).

Zach was aware of the importance of the test, but could not fully appreciate the pressure that is put on teachers with students who struggle. As he would further mention, he took mostly AP classes, freeing his teachers from the responsibility and pressure of the BSBT.

Zach's goal system at the end of the semester

There was no change in Zach's goal system between January and May. At the end of the semester, Zach again held two independent cognitive policies: teaching the BSSS and having his students get good scores on the BSBT (see figure 4.12). Whereas A.C. viewed the teaching of the BSSS as a means to achieving good test scores, Zach does not express this connection. I detail these two independent cognitive policies below.

First, Zach expressed the cognitive policy of teaching the BSSS. When asked how he will determine what chemistry content students will need to learn during his first year of teaching, Zach responded it would be "based off the [BSSS]" (Interview 3). Zach mentioned that the BSSS also influenced the sources he sought out for lesson and activity ideas. He mentioned that during his student teaching semester, he was able to get lessons from a single curricular resource because “a lot of them [the lessons posted] dealt with the [BSSS], so we were able to use that [resource]” (Zach, Interview 3). Zach would continue that he expected to draw heavily from this resource again the following school year, in large part due to his familiarity with the resource and the comfort in knowing they were based upon the BSSS.

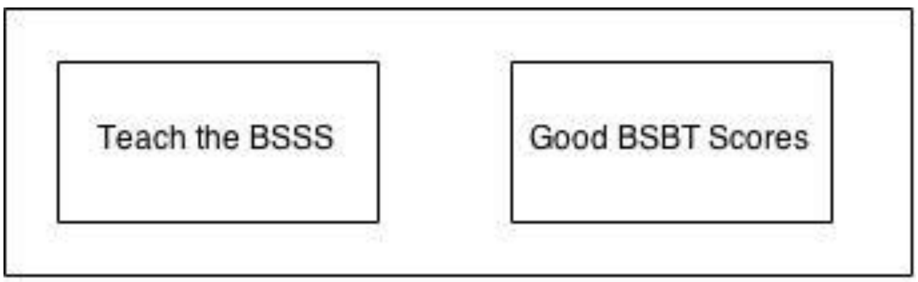

Figure 4.12: Zach’s Systemic Reform Goal System, May

Zach’s second cognitive policy related to Big State’s systemic reform policy was for his students to have good scores on the BSBT. Zach expressed similar sentiments in May to those he expressed in January related to the BSBT, mentioning that schools and teachers are often evaluated based upon the BSBT. When asked how he would be evaluated the following school year, Zach stated that “to [him], it seems the [BSBT is] the only thing that you’re looking at. So, I don’t really know what else they’re observing” (Interview 3). For Zach, he felt that student test scores factored prominently in his evaluation, to the exclusion of other things that administrators might observe. Zach further recognized that “they [school administrators] seem to be very stressed about biology since it's the only science that is…tested now" (Interview 3). At the same time, Zach had difficulty reconciling his knowledge of how teachers are evaluated (BSBT test scores) with the knowledge that biology is the only science subject tested under Big State's systemic reform policy, and he wanted to primarily teach chemistry. Thus, he was at a loss to explain the relationship between the BSBT and his evaluation as a chemistry teacher.

Zach's goal conflicts at the end of the semester

At the end of the semester, Zach did indicate one conflict between his pedagogical goal system and his cognitive policy to teach the BSSS. Zach had mentioned that he had been interviewed for a few teaching positions prior to our final conversation, and this led him to reflect upon the systemic reform policy of Big State. "The fact is, that it does seem like a lot of people are stressing the importance of getting good teachers…obviously, for biology" (Zach, interview 3). Zach knew that there was significant pressure on teachers to teach the BSSS and to get good scores on the biology BSBT, but the process of interviewing for jobs had brought those concerns to the forefront. Thus, Zach began to experience a conflict between his desire to teach the BSSS and his desire to teach in culturally relevant ways (see theme 1).

When asked if cultural relevance is compatible with the BSSS, Zach responded:

> I would say, actually probably most of the time, it's not but that's a way that you can bring the [BSSS] in and make them interesting, so now they have meaning. You're able to see that you're not just learning some random science but you're learning some sort of science that you can tie back to your normal everyday life.

> And then you start thinking about it more and then you'll become more competent in that [standard] (interview 3).

Unfortunately, Zach also recognizes that this may not be congruent with the approach the rest of the school takes. Again, while thinking about his job interviews, Zach mentioned that he was unsure how supportive his administrative team would be of this approach to teaching science. Thus, Zach is conflicted by his desire to teach the BSSS and use a culturally relevant curriculum in his class. For the time being, this conflict is resolved via Zach's approach by using cultural relevance as a framework for making the BSSS meaningful. Zach is also mindful that he may need to take a different approach to resolving this conflict, conditional upon the school that he will teach at his first year.

Analysis of Zach's goal systems

Zach had the least developed set of cognitive policies related to Big State's systemic reform policies. Furthermore, there was very little change in his cognitive policies between January and May. First, Zach held the cognitive policy to teach the BSSS, as they provided a set of content standard to guide his teaching. At no point in either January or May did Zach justify this choice by appealing to the BSBT or to the authority of Big State. Instead, Zach stated his cognitive policy as fact, and then moved on. Similarly, while Zach held the cognitive policy of helping students do well on the BSBT, he was not able to elaborate much regarding his justification for this. Zach knew that the BSBT was important for schools and would likely play a role in his classroom if he were to teach biology. However, he did not elaborate much beyond again stating the cognitive policy.

Finally, Zach expressed a goal conflict between his desire for culturally relevant curriculum and teaching the BSSS. Zach hoped that he would teach at a school where the culture of the science department permitted him to resolve this conflict in a constructive way—via embedding cultural relevance into curriculum that covered the BSSS. At the same time, he recognized this may not be the case, as some schools favor a more traditional approach to teaching science. As of our last interview, Zach had not resolved this potential conflict.

Kelly's goal systems reflective of systemic reform policy

Kelly's goal system at the beginning of the semester

At the beginning of the semester, Kelly held two branches in her goal system (figure 4.13). First, Kelly held a branch with teaching the BSSS at the top with a subordinate cognitive policy of following the official curriculum guides of the school and district in which she worked. Kelly also held a second, independent cognitive policy related to helping students get good test standardized test scores, including scores on the BSBT. I detail Kelly's cognitive policies below.

The first cognitive policy that Kelly held is to teach the BSSS. When discussing how Kelly would decide what chemistry content to teach the following spring, we had the following exchange:

> Kelly: There is a lot of objectives that the students have to understand before taking the [BSBT] and it's kind of the Department Head's responsibilities to ensure that, oh yeah, the teachers are on track in teaching their students these objectives.

Todd: So who decides those objectives?

Kelly: The state.

Todd: The state?

Kelly: I guess not the state; the state itself is [Big State], so [Big State] is not. But I am not entirely sure whom the Board consists of. I am assuming that those who make the objectives are a Board of administrators, a Board of other teachers that have had experience that determine, okay, in this subject it is important for students to understand this objective in order to be successful in understanding that, in mastering it.

In determining the actual content of her chemistry course, Kelly, to a very large extent, defers to the authority of Big State to set the content priorities and the authority of the department head to enforce the state's priorities.

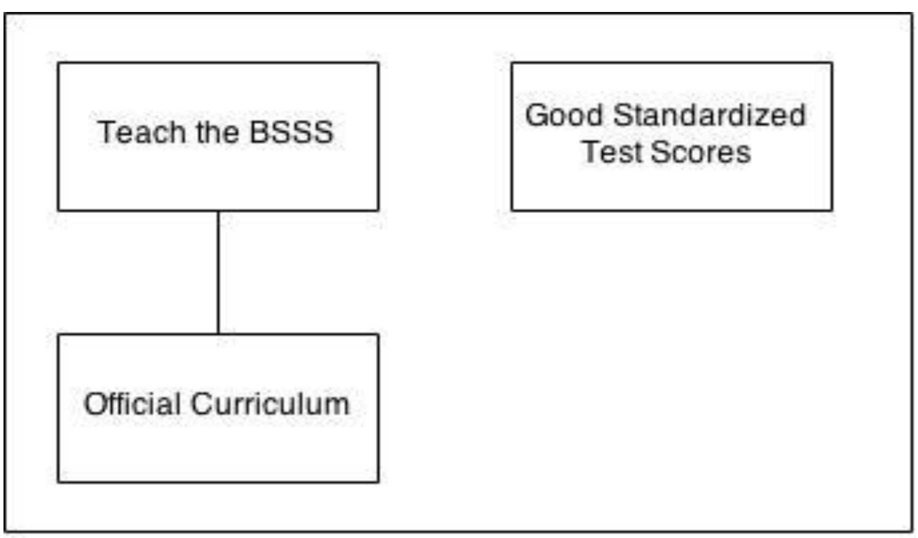

Figure 4.13: Kelly's Systemic Reform Goal System, January

As a means of achieving the cognitive policy of teaching the BSSS, Kelly also held a cognitive policy to follow the curricular guidance of the school and district—particularly the department head. She mentioned that the department head usually manages the curriculum for teachers, and holds them accountable for covering the BSSS in a timely fashion. Kelly would mention that the department head "oversees the curriculum" and that it is her responsibility to "stay on track" (Interview 1). Kelly entered the student teaching semester with the cognitive policy to defer to the department head on curricular matters. This cognitive policy may also derive from and support other goals Kelly expressed, such as working well with other teachers. However, it is clear that she also follows the lead of the department head because she recognizes the importance of covering all of the mandated BSSS coupled with her lack of experience in planning a full year's worth of curriculum.

Kelly held an independent cognitive policy of helping students pass standardized tests that was partially in response to Big State's systemic reform policy. To a large extent, Kelly adopts this cognitive policy in response to the priorities of the school she expects to teach at the following fall. Thus, the focus of Kelly's cognitive policy related to the BSBT is not on her own class per se, but on the role she and her class may play as part of the school. Kelly would mention that schools take test scores very seriously and expressed a desire to work in a school that would support her as she dealt with "the stresses of standardized testing" (Interview 1). She also felt that standardized test scores were a common way for others to judge the effectiveness of schools. In her words, "the only way a lot of people gage whether or not schools are effective is just based upon the reflection of their test scores. Like, the standardized scores, and AP testing" (Kelly, Interview 1). Kelly recognizes the importance of test scores, but at the same time distances herself from the BSBT by referencing the AP test—a test she anticipated playing a much larger role in her teaching career.

Kelly was quite comfortable and unconcerned with the BSBT as it related to her because "it just seems to be questions that reflect the objectives [the BSSS]" (Interview 1). Kelly knew this based upon her own experiences in taking the previous incarnation of the BSBT, mentioning that the questions "seem very basic in general" and that even though "they change the name, they change the acronym every year… the test is still the same" (Interview 1). Thus, Kelly does not seem to worry about her students passing the BSBT, as effectively teaching the BSSS will lead to strong performance on the BSBT. This may also result from her plans to teach chemistry—a subject not tested under Big States systemic reform policy.

Kelly's goal system at the end of the semester

Recall from chapter 3 that prior to our final interview, Kelly accepted a job for the fall semester at Private High, a private high school in Capital City. Thus, Kelly disengaged from most of the goals she held related to Big State's accountability policy. This, in and of itself, is not surprising. What is surprising, is that Kelly *did not* disengage from the goal to teach the BSSS (see figure 4.14). Despite the fact that she knew that her future school would not be bound to the educational policies governing Big State, she remained committed to the cognitive policy of teaching the BSSS. I detail this cognitive policy below.

When asked how she would determine the content of her chemistry class the following year, Kelly mentioned that "it's the same way as most schools work. It's just going through the objectives and saying which ones make the most logical sense to build upon another" (Interview 3). As a follow up, Kelly was asked where Private High gets their objectives from, to which she replied:

> I assume the textbook companies. No, I think they follow the [BSSS] as well [as public schools]. And, they follow the order that the textbook company suggests, if it makes sense. If not, they just tweak it themselves. But, I guess that's the basis they follow (Interview 3).

At other points in our conversation, when asking Kelly how she determines what students need to learn—a similar question to an earlier question framed in a different manner—she again responded that "it has to do with the objectives" (Interview 3). Kelly places the BSSS front and center in regards to her goals for teaching her students chemistry content.

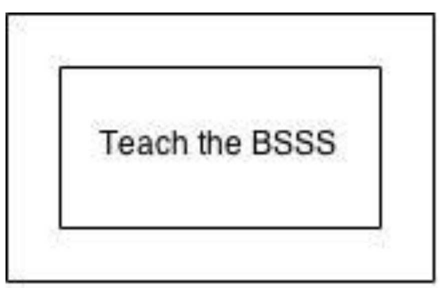

Figure 4.14: Kelly's Systemic Reform Goal System, May

Interestingly, Kelly was aware that by teaching in a private school, she did not have the same responsibility to abide by state policy as those teachers in public schools.

When asked what she would do if she encountered a standard on the BSSS that she did not like, Kelly mentioned that, if that were the case, she would "bring it up with other teachers and if they agree, then you can just toss it out" (Interview 3). Kelly further elaborated that "I would assume since there is no more state testing, that you can [toss out a standard]" (Interview 3). Kelly is patently aware that state accountability policy no longer applies, and that gives her freedom to discard certain standards. At the same time, she does not entertain the possibility that she is not bound to any of the BSSS. For Kelly, the goal to teach the BSSS was so strong that she was unable to disengage from this goal—even in a setting where she is, to some extent, aware that she is allowed to do so.

Kelly's goal conflict at the end of the semester

At the end of the semester, Kelly experienced a conflict between her cognitive policies of teaching the BSSS and teaching relevant content. When asked if the BSSS are compatible with the making content relevant, Kelly replied that "the [BSSS] aren't made to make it relevant. The [BSSS] are made to structure what it is that we need to teach in the classroom" (interview 3). She would further mention "in terms of relevance, that is the teacher's responsibility, not the [BSSS]" (interview 3). The conflict arises when Kelly reflected upon the ease with which she can make the BSSS relevant. Unfortunately, Kelly unequivocally responded that no, it is not easy to make the BSSS relevant. As a result, she often failed to achieve her cognitive policy of making content relevant, and was unsure if that would change the following year.

Again, this goal conflict is interesting in that Kelly is not bound to the BSSS. Having accepted a job at a private school, Kelly can teach the curriculum that she chooses in the manner that she chooses. And yet, the cognitive policy of teaching the BSSS is so strong that she is unable to think about her teaching content not included in and defined by the BSSS.

Analysis of Kelly's goal system

Like the other three student teachers in this study, Kelly held the cognitive policy of teaching the BSSS in both January and May. In January, Kelly justifies teaching the BSSS via her appeal to the authority of Big State to define content standards for public schools. Interestingly enough, Kelly internalized the definition of chemistry via the BSSS to such a degree that she was unable to envision teaching chemistry without such guidance. Despite the facts that: (1) Kelly was going to teach in a private school; (2) she justified teaching the BSSS in response to state authority in January; and (3) she recognized that other aspect of Big States educational policy no longer applied to her in the private school, Kelly remained committed to the cognitive policy of teaching the BSSS in May.

Kelly also exhibits evidence of the second pattern, namely that a strong commitment to a cognitive policy of having students pass the BSBT coincides with a structured goal hierarchy related to Big States systemic reform policy. In January, Kelly held such a cognitive policy, and also expressed clear means-ends relationships amongst her cognitive policies. At the same time, she did not integrate this cognitive policy into the means-ends relationship between teaching the BSSS and following the district mandated curriculum. By May, when Kelly had accepted a job with a private school, she disengaged from all cognitive policies save teaching the BSSS.

Due to her continued commitment to teaching the BSSS, Kelly developed a goal conflict between the BSSS and her pedagogical cognitive policies, particularly making content relevant. Kelly realized she continued to struggle with making content relevant when teaching the BSSS, and had yet to resolve this conflict. Finally, this conflict exists despite her knowledge that she is not bound to the BSSS at a private school.

Jessie's goal systems reflective of accountability policy

Jessie's goal system at the beginning of the semester

At the beginning of the semester, Jessie had an overarching cognitive policy of having her students perform well on the BSBT (see figure 4.15), co-occurring with a more structured goal system. As a means to achieving this cognitive policy, Jessie held two subordinate cognitive policies of teaching the BSSS and giving students opportunity to practice BSBT formatted questions.

The first cognitive policy that Jessie adopted as a means to having students pass the BSBT was to teach the BSSS. Like the other teachers in this study, when asked how she would determine what content to teach, Jessie mentioned she would follow the guidance of the BSSS. In her own words, Jessie justified this decision because "that's state wide. That's the [BSSS]…everyone has the same [BSSS] all over the state" (Interview 1). Jessie justified deferring to the BSSS to determine the content of her class in the fall for two reasons. First, when discussing the BSBT, Jessie mentioned that "there are [BSSS] for a reason" (Interview 1). The reason being to delineate what content could potentially be tested on the BSBT.

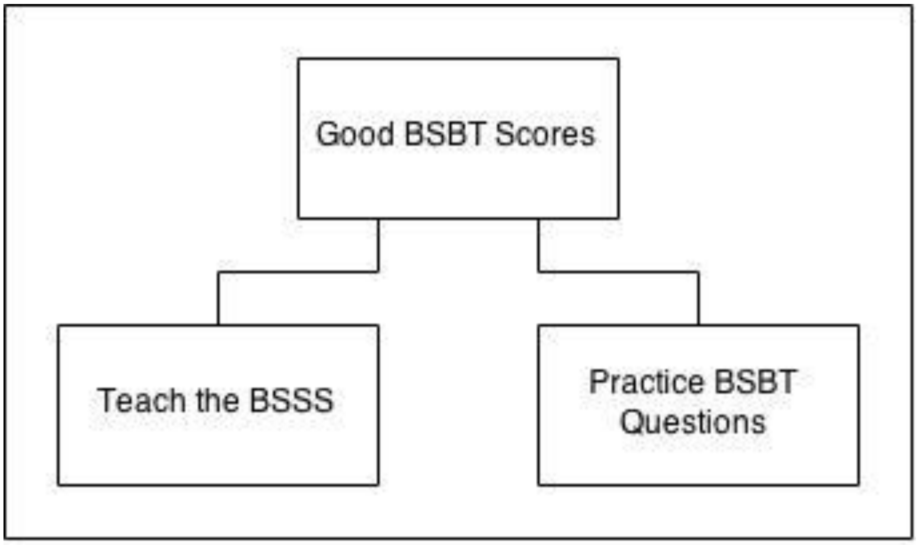

Figure 4.15: Jessie's Systemic Reform Goal System, January

The second reason is that Jessie agreed with the rationale that the BSSS exist "so everyone's on the same playing field. All those students [students across Big State] are required to know the same things, so that some students aren't at a disadvantage" (Interview 1). To a very large extent, Jessie internalized these justifications and based instructional decisions off the BSSS. In her portfolio, she mentioned that in creating the lessons, she "assessed the validity of the activities that we chose to incorporate by their adherence to the [BSSS]" (Jessie, teaching portfolio, 3/1/2014). In other words, the validity of a lesson is a function of its fidelity to the BSSS.

Finally, Jessie justified her adherence to the BSSS and made clear the hierarchical relationship between the BSSS and the BSBT in her goal system when discussing her ability to augment the BSSS with additional content. When asked if she could teach something not in the BSSS, Jessie responded:

> I mean, you could probably. But [pause], it might make your principal mad. Because, he probably—he or she might think it's a waste of time because [students] are not going to be tested over it. That's kind of, pretty controversial, I think, to do that. (Interview 1).

The quest to avoid angering her principal is a topic that comes up again when examining Jessie's goal system related to the human dimension of the school organization. More importantly for her goal hierarchy related to systemic reform policy is that preparing students for the BSBT is of primary importance, and that teaching topics outside the BSSS takes time away from teaching those topics that are covered on the BSSS.

The second cognitive policy Jessie pursues as a means to having students perform well on the BSBT is that of having students practice BSBT-formatted questions. In recalling her own experiences taking the precursor test to the BSBT, Jessie mentioned that "it would be little things that, if I had practice doing it, I would have gotten it right on the [precursor test]. Or, whoever else in my class would have gotten it right" (Interview 1). Jessie would further elaborate by mentioning this was the case even with more advanced students, smart students "who know this stuff" (Interview 1). By this, Jessie meant that the authors of the BSBT would write questions in a way that they could trick students into getting a question wrong, despite the fact that the student knows the underlying content. Jessie felt that the more exposure to and experience with answering BSBT-formatted questions, the less likely students were to fall for the test authors tricks.

In response to this, Jessie plans to have a daily warm up activity where students answer a BSBT formatted question. In her own words, each class would start where students:

> Have to do some sort of [BSBT] prep, and that probably is going to be in the form of a warm up. It doesn't have to be super boring, it could be like, do your warm up and we can answer it on a big post-it and you can come and put up your post it. Probably something like that, and that's probably going to take about ten minutes (Jessie, Interview 1).

Jessie felt so strongly about the importance of practicing the BSBT type questions that she was willing to devote ten minutes of an hour long class each day to the warm up (teaching portfolio, 2/1/2014). Furthermore, Jessie felt that because of the "tricks" inherent to the BSBT, this warm up was important for students in all levels of her class.

Jessie's goal system at the end of the semester

At the end of the semester, and after Jessie accepted a job teaching 6th and 7th grade science at Magnet middle school (MMS), Jessie's goal system regarding systemic reform policy has become much less structured (see figure 4.16). At this point in time, Jessie held two cognitive policies—having students pass the BSBT and teaching the BSSS. In comparison to her goal system in January—where there existed a means/ends relationship between the BSBT and the BSSS—these two cognitive policies exist independently of each other in May. Furthermore, Jessie disengaged from the cognitive policy of having students practice BSBT-formatted questions.

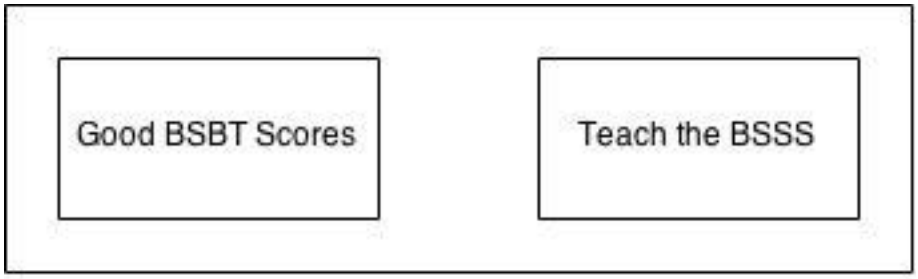

Figure 4.16: Jessie's Systemic Reform Goal System, May

In talking about the BSBT with Jessie at the end of the semester, Jessie mentioned that schools are evaluated based upon scores on the BSBT. She would rhetorically ask "how else would a school be evaluated" (Jessie, Interview 3), answering her own question by mentioning she couldn't think of a way other than test scores? Jessie recognized even for her magnet school, good test scores were important, as the school would be evaluated based upon BSBT scores.

Jessie also recognized that, unlike the school she was placed at for student teaching, having students pass the BSBT was less a goal of instruction and more an expectation. In other words, her cognitive policy was as much about having students *not fail* the BSBT as it was about them passing the BSBT. In describing the school's approach to the BSBT, Jessie mentioned that "honestly, they [students] are expected to do well on the [BSBT]" (Interview 3). Jessie would continue that because it was a magnet school, the assumption was that most of her students would not have a problem with the BSBT unless she was doing something wrong.

That she was teaching at a magnet school where the students had little trouble passing the BSBT also resulted in Jessie dropping the cognitive policy of doing the

BSBT-formatted questions for a warm up each day. When asked if she planned to do the BSBT warms ups with her students at MMS, Jessie responded:

> No, not like that [the daily warm ups]. I don't think it's going to be like that. Every now and then, I might have a [BSBT] formatted question. But, the warm ups there [MMS] are probably—they probably want them to be more creative. (Interview 3).

Again, while Jessie realizes the importance of passing the BSBT, she also feels that her future students at MMS will not need as much practice with the BSBT-formatted questions. While she does continue to hold the cognitive policy of having students pass the BSBT, she frames this as a secondary goal relative to the other goals she may adopt for her students in the magnet program.

The second cognitive policy Jessie held at the end of the semester was to teach the BSSS. However, Jessie felt the BSSS functioned more as a baseline for her teaching than as the overall framework of her instruction. When discussing the BSSS, Jessie mentioned "that's where you start. I think that's just more of a starting point" (Interview 3). She further suggested that the BSSS form a "very good guideline" for deciding what students need to learn. However, she felt that her instruction would transcend the BSSS to include both a broader set of content topics as well as to be more creative.

Analysis of Jessie's goal system

Jessie, like the other student teachers in this study, held a cognitive policy of teaching the BSSS. In January, this cognitive policy was subsumed under the cognitive policy of helping her students pass the BSBT. In May, Jessie still held onto the cognitive policy of teaching the BSSS, expressed in a different manner than in January. As she had already accepted a job with MMS, she no longer taught the BSSS as part of her goal to have students pass the BSBT. Instead, she used the BSSS as a starting point for instruction that she felt she could move beyond. This may be a result of her accepting the job at MMMS in two ways. First, by accepting the job at MMS, Jessie redefined her cognitive policy related to the BSBT. Second, by working with magnet students, Jessie felt that they would more easily learn the baseline content represented by the BSSS, freeing her to supplement her classroom with content not part of the BSSS.

Also evident in Jessie's goal systems is evidence for the second pattern—that the strength of the cognitive policy to have student pass the BSBT coincided with the degree of structure to the goal system. In January, Jessie held a very strong commitment to the BSBT. However, by May, the strength of the cognitive policy to have students pass the BSBT had decreased. Furthermore, this cognitive policy transitioned from explicitly striving to help students pass the BSBT to ensuring that students do not fail the BSBT. This difference is more than just semantics. Shah and Kruglanski (2007) distinguish between approach goals (passing the BSBT) and avoidance goals (not failing the BSBT), and note that framing a goal as an approach or avoid goal can have large influence on the outcome of cognitive processes.

At the same time, between January and May, the structure of Jessie's goal system became much less hierarchical and more compartmentalized. Whereas in January there was a means-ends relationship between the two cognitive policies of the BSBT and BSSS, by May, this relationship was no longer evident. Furthermore, in January, Jessie held a second lower level cognitive policy of having her students practice BSBT style questions. In May, she had disengaged from this goal. While she offhandedly mentioned it may be something she does every once in a while, she did not in any way express a desire to structure her class around BSBT warms ups like she did in January.

Goal Systems Related to the Human Dimension of the School Organization

In this section, I detail the cognitive policies of the student teachers in relation to the human dimension of the school organization. This is important in answering the question of why science teachers do what they do when they teach science because, as Ingersoll (2003) mentions "it is simply not true that, behind the closed door, classrooms are small universes of control with the teacher in sole command and free to do as they please" (p. 234). Ingersoll (2003) continues that schools have the characteristics of other organizations, such as division of labor, hierarchical systems of management, and formal rules and policies. Thus, for many, in order to fully understand teaching, we must begin to more completely take account of the school as an organization (Packer & Winne, 1995).

Formally, organizations are systems of coordinated activity amongst numerous people in pursuit of common organizational outcomes—in the case of schools, student learning (Ingersoll, 2003; March & Simon, 1993; Meier, Polinard, & Wrinkle, 2000; Wilson, 2000). Organizations are able to achieve more via collective, coordinated action than the sum of their individual members would achieve without such coordination (Allison & Zelikow, 1999; Meier, Polinard, & Wrinkle. 2000). Yet, individuals come to organizations with different knowledge, beliefs, interests, and skills (March & Simon, 1993). Thus, organizations consistently face the problem of continued coordination of members—having members work toward the same end (Ingersoll, 2003).

Often, members of organizations achieve this coordination implicitly, as members not only hold a desire to work toward similar ends, but the desire to work well with other members of the organization. Organizations, including schools, are able to foster coordinated action amongst individual members in part because each member holds cognitive policies governing the way they work with other people. In other words, teachers do not make pedagogical and curricular decisions based solely upon their cognitive policies for students. Instead, they may also take into account their relationships with other members of the school—such as other teachers, or the principal—when making decisions in their classroom.

Three patterns emerged when exploring the goal systems of these student teachers with respect to the human dimension of the school organization. The first pattern, in response to the main research question, was that each student teacher held the cognitive policy to collaborate with the other science teachers at their school. They often hoped that via collaboration on lesson planning, assessment and/or classroom management, they would benefit from the experience and expertise of the more veteran teachers at their school. Moreover, this cognitive policy remained with each student teacher for the duration of the semester. This is important, as there was variability in the degree to which each student teacher partook in department wide collaboration at their student teaching school. A.C. attended all the science department meetings, and worked with the department as a whole to plan lessons and prepare students for the BSBT. Jessie planned with only her grade level team and Kelly planned only with the other chemistry teachers at Sands High. Finally, Zach only worked with his cooperating teacher, Mr. Morris, as there was only one astronomy teacher at Bayside High. Despite this variability, all teachers expressed a commitment to the cognitive policy of working with the more veteran teachers as they continued to mature into their teaching career.

The second pattern to emerge is that, compared to the other two domains previously explored in this chapter, the goal systems for the student teachers were much less developed. This lack of development manifests itself in two ways. The first is that the student teachers held fewer cognitive policies within their goal system related to the human dimension of the school organization than they did for their goal systems reflective of their teacher education program or Big States systemic reform policy. The second manifestation of the lack of developed goal systems is the lack of a hierarchical arrangement for the goal systems of all the student teachers in both January and May. In other words, these student teachers held a small number of independent cognitive policies related to this domain[8].

The third pattern to emerge was that A.C., Zach and Jessie all held cognitive policies related to pleasing their principal. In other words, one of their cognitive policies is recognizing the authority of the principal as the instructional leader of the school and to follow the curricular approach they ask the school to adopt. Interestingly, all three disengaged from this cognitive policy by the end of the student teaching semester. To be

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[8] Because of the lack of structure to the goal systems in this domain, I chose not to provide figures of the independent cognitive policies.

clear, this does not meant that they in some way want to anger their principal. Instead, it means that they no longer have the cognitive policy to please their principal, and they do not intend to make classroom decisions with respect to their principals desires and wishes.

Finally, in response to the question regarding goal conflicts, A.C., Zach and Kelly all expressed a goal conflict between their pedagogical goal system and their cognitive policy of collaborating with the other science teachers. Of agreement between the three of them was that other teachers may be set in their ways—traditional, lecture based classes. They felt this went against what they learned in teacher education and what they felt was best for students. Thus, all three experienced the conflict between collaborating with their department and using what they had learned in teacher education and believed to be best practices.

Interestingly, they do not resolve this conflict in the same way. A.C. resolves this conflict by modifying his goal to collaborate in various ways, expressing the willingness to isolate himself from the department if that was his only recourse. Zach, on the other hand, is willing to modify his pedagogical cognitive policies in an effort to integrate himself with the other science teachers. And finally, Kelly adopts a cognitive policy of managing the politics of her science department—a strategic way of both collaborating and implementing her own pedagogical cognitive policies.

Below, I detail the goal systems for each of the four student teachers related to the human dimension of the school organization.

A.C.,'s goal systems reflective of the human dimension of the school organization

A.C.'s goal system at the beginning of the semester.

At the beginning of the student teaching semester, A.C. held two cognitive policies related to the human dimension of the school organization. The first cognitive policy that A.C. held was to please his principal. The second cognitive policy was to work with other teachers, specifically the science department. I detail each cognitive policy below.

The first of A.C.'s cognitive policies was to please his principal. This cognitive policy was related to his desire to help ease the pressure placed on the school by the state via their accountability policy. As such, the principal has a responsibility, according to A.C., to "[up]hold what the state is trying to do" (interview 1, pt. 2). A.C. would further suggest that if the principal does not follow through on their responsibility to the state, "the school can get audited and then they could get in trouble for not doing certain things" (interview 1, pt. 2). Thus, the primary responsibility of the principal is to "hold their teachers accountable. They [the principal] have to be making sure that certain things get done" (A.C., interview 1, pt. 2)—things mandated by the state via formal policy.

Thus, A.C. mentioned that part of his job is to do those things his principal asks him to do as part of fulfilling the state mandates. A.C. continued that he expects his principal will "always [be] talking about ways to improve" (interview 1) in response to these mandates. By ways to improve, A.C. is referring to ways to become a more effective teacher for his students. A.C. also mentioned that a related responsibility of the principal will be to come and observe him as part of the processes of "holding teachers accountable." A.C. welcomes the observation of his principal, stating that "if I am going to be a teacher, I want to be good at what I do. So, I wouldn't really care that I am being observed" (interview 1, pt. 1). He would continue that he cares about being an effective teacher, and that observations of his teaching by his principal will be an opportunity to demonstrate this first hand to his principal.

The second cognitive policy that A.C. held in January related to the human dimension of the school organization is his desire to work well with other teachers. A.C. mentioned that he hopes he will develop good relationships with the other teachers in the science department. This was important to A.C. because "if you get along with the people that you are working with, you could be more productive and talk about lessons more" (interview 1, pt. 2). A.C. added "you are going to have people who want to help you out when you go teach" (interview 1), implying that there will be opportunities to work with other teachers to improve his own teaching.

A.C. also expressed an expectation to work with either the science department as a whole or the biology teachers specifically to plan lessons and common assessments. In describing how he hopes to plan his lessons the following school year, A.C. suggested "as a department, as a whole, kind of talk about 'oh, I got this hand out,' 'I got this hand out'" (interview 1, pt. 1) and build lessons in a collaborative atmosphere. A.C. held as his cognitive policy the desire to collaborate with more experienced teachers leading to better teaching on his part.

A.C.'s goal conflicts in the beginning of the semester

In January, A.C. experienced a very strong conflict between his desire to work with other teachers and his desire to be an effective teacher. A.C. mentioned that there "are some teachers that just give up, they just give up on students too soon" (interview 1, pt. 1), which leads to classroom practice that A.C. deemed less than effective. It was clear to A.C. that these teachers "are not passionate about what they do and that comes across in their lessons" (interview 1, pt. 1). A.C. was worried that in schools with teachers like this, other members of the school organization expect a "classroom that's probably quiet, behaved and students reiterating what the teacher is saying verbatim" (interview 1, pt. 1). Thus, A.C. was conflicted by the interplay of his cognitive policy to work with other teachers and the expectation that these other teachers will promote practice and pedagogy that he feels is not effective.

A.C. expected to resolve this conflict by doing his best to limit his interaction with those teachers who are not, in his words, "passionate" about teaching. While recognizing that he may be required to meet with these teachers in faculty and department meetings, he did not feel the need to seek out their company in informal settings. In his own words:

> At lunch, I might just stay in my room, help students if they need help. Because I have sat in some of the teacher's lounge conversations here [at student teaching school] and it's just like…it's a lot of bickering and a lot of complaining, and…I don't know. If you hear so much negative all day, all the time, it could affect you

a bit. So, I would probably be the type of teacher that takes my own lunch, eat in my room. (A.C., interview 1, pt. 1).

A.C.'s desire to teach in ways congruent with his teacher education program trumped his desire to work with other teachers. In this case, instead of fostering relationships with other teachers in an informal setting—the teacher's lounge—A.C. chooses to retreat from the lounge in order to maintain his own priorities.

A.C.'s goal system at the end of the semester

At the end of his student teaching semester, A.C. held a single cognitive policy related to the human dimension of the school organization: collaborating with the other science teachers, having disengaged from the cognitive policy of pleasing his principal.

In thinking toward his first year of teaching, A.C. mentioned how he "would like to have positive interactions [with other teachers], especially with the science department" (interview 1). For A.C., part of having positive interactions was working with the science department to plan quality instruction for his students. Recognizing that he would be bringing limited curricular resources to his future school for the biology class he hoped to teach, A.C. recognized he will "be pulling resources from everywhere to get lessons" (interview 3). One way to do this would be to collaborate with the other science teachers at his future school.

Similar to his expectations in January, A.C. expected the collaboration to focus more on improving past lessons than to start from scratch—something A.C. was open to. A.C. felt that lesson planning in the science department would focus on teachers asking "how effective was this? Did this work [last year]" (interview 3)? A.C. continued that in response to those questions, he wanted to aid his future teachers in discussing how they should change or supplement previous years lessons. He did, however, recognize there might be times where the group would decide "to get rid [of a lesson] altogether" (interview 3). This would allow A.C. to interject some new ideas, leading to a larger role in the science department's collaboration.

A.C.'s goal conflict at the end of the semester

As was the case at the beginning of the semester, A.C. expressed a conflict between collaborating with the science department and his preferred pedagogical approach to teaching science. Similar to statements A.C. made in January, in May, A.C. mentioned:

> There are lots of teachers that like doing things a certain way, where it's just "oh, here is your handout. Turn to this page. Copy the definitions. Here is your test." Either because they are too tired or they just don't care anymore. And, that's not what I am trying to do (interview 3).

A.C. further recognized that, for teachers such as those he described above, "if you start trying to change too much before you're in the system [i.e. seen as a member of the school], you might get some pushback" (interview 3). Pushback from other teachers was something that A.C. fully expected to encounter the coming school year, mentioning this possibility throughout the final interview.

In this case, A.C. mentioned multiple avenues to mitigate the pushback he receives from other teachers. One way to mitigate pushback that A.C. mentioned is for the science department to adopt a common assessment approach to curriculum, where all biology teachers are required to give students identical tests and quizzes, while having the freedom to teach in ways they individually choose. A second approach to reducing the pushback from other teachers that A.C. mentioned is to "talk with an administrator…and be like 'you know what, the [department] wants to do this. I want to do that with my lesson" (A.C., interview 3). A.C. would continue that a good administrator would support him in this endeavor. The third approach, conditional on an administrator telling him that he had to use a common curriculum, is to "get through the lesson quick and then add supplemental stuff" (A.C., interview 3). He would justify this to his administrator and other teachers by saying "you told me I had to teach this, so I taught it in a shorter amount of time…and then I supplemented that material with this [additional material]" (A.C., interview 3). A.C. felt confident this last resort approach would still be acceptable to the other teachers and administrators in his school.

Analysis of A.C.'s goal system

A.C. showed evidence of all three patterns. A.C. held two independent cognitive policies in January—pleasing his principal and collaborating with the other science teachers. By May, he had disengaged from the cognitive policy related to his principal. Thus, all three patterns are represented: collaborating with other science teachers, a lack of structure in his goal system, and the presence of a cognitive policy of pleasing his principal, albeit a cognitive policy he disengaged from by May.

A.C. also expressed the same conflict between his pedagogical goal system and his desire to collaborate with the other science teachers in both January and May. Furthermore, he expressed unwillingness to discard the research based methods that he learned during his teacher education program in light of this conflict. Instead of acquiescing to the poor teaching practice that other teachers may propose, A.C. instead remains steadfast in pursuit of his cognitive policies detailed in the first theme. The conflict is resolved via modification of the cognitive policy to work with other teachers. Finally, when compared to the same goal conflict in January, by May A.C. has become more proactive in his approach to resolving the conflict.

Zach's goal systems reflective of working in an organization

Zach's goal system at the beginning of the semester

In January, Zach held two similar, yet independent, cognitive policies related to his interactions with the other members of his school. The first is to work well with and be open to mentoring from the other teachers at the school. The second cognitive policy is to be open to the mentoring from the principal. I detail each cognitive policy below.

The first cognitive policy that Zach held was to work well with the other teachers, particular in a way that they will be willing to mentor him. First, Zach mentioned his desire to "fit in with the school as much as I can" (interview 1). As part of fitting in, Zach mentioned that he wanted to work with the other science teachers in the school to plan and develop lessons. While Zach wanted to teach chemistry and/or biology, he mentioned that he wanted his collaborative efforts to include science teachers across all disciplines. In elaborating on this desire, Zach mentioned that "a lot of the sciences are interrelated. It would be really cool to just work with them [other science teachers] either on a project or just an activity" (interview 1). The first facet of working well with other teacher was for Zach to foster collaborative relationships with the other science teachers at his school.

The second facet of Zach's cognitive policy to work with other teachers was to engage the more experienced teachers in a mentoring relationship. Zach recognized that "there is always a way to improve [his teaching]. There is always good feedback…maybe your class doesn't need it, but maybe your future classes [do]" (interview 1). Thus, as part of his desire to continually improve his craft, Zach hoped the other teachers he worked with would provide feedback on his teaching. Zach planned to:

> Ask [other] teachers if they could come in and maybe just sit in a class. Maybe have some free time, preferably like a longer duration, maybe 30 minutes or something, at least. They just sit in my class and see what they think or maybe what I can improve on (interview 1).

Zach hoped to that the other teachers at his future school would be willing to lend him their time and their expertise as he continued to develop as a teacher.

The second cognitive policy related to the other members of the school that Zach held in January was to receive mentoring from his principal. When talking about what he thought a good principal does, Zach suggested he "would really like for them [the principal] to give me their insight on what I have done" (interview 1). Zach continued that "they [principals] are probably past teachers so they would be like, 'hey, I did something like this, or I tried this before and it didn't work.' I would like feedback of that sort" (interview 1). Zach would further elaborate this would occur both as part of informal observations as well as his formal evaluation for the school year.

As part of this mentoring process, Zach recognized that he may not have a principal who was a former science teacher. In that case, Zach expected they "would know a lot of different types of teaching. Maybe they didn't do inquiry [when they were a teacher] but they should know that" (interview 1). Zach would further suggest that if his principal did not have much familiarity with inquiry, there were still practices that all teachers can do in their class, regardless of subject matter. In his words, "even if they were an English teacher, all they did was teach English and they walk into my science class, there is still some cross over in just teaching style that they should be able to help out" (interview 1). Thus, Zach felt comfortable with and planned to ask his principal to engage in this mentoring relationship as he continued to develop as a teacher.

Zach's goal conflicts in the beginning of the semester

Like A.C., Zach experienced conflict between his cognitive policies of working with other science teachers and delivering high quality instruction to his students. While Zach made it quite clear that he wanted to do inquiry, he also recognized that other teachers may not approach their classes in the same manner. Instead, he felt "a lot of the older teachers will just lecture" (Zach, interview 1). Zach was concerned that the more experienced teachers would be "stuck in their ways. 'This worked for me. It will work for every other teacher'" (interview 1). Zach further feared that these "stubborn teachers," as he called them, might harm him professionally, mentioning that "your coworkers can help you or they can hurt you" (interview 1). In other words, they can make his experience as a new teacher either easy or difficult, depending on the degree with which he was willing to follow the lead of these more experienced teachers.

In response to this, Zach was willing to limit his use of inquiry as part of adopting curricular approaches established by the experienced teachers and the administrative team supportive of those approaches. Zach mentioned that in this case, he would attempt to game the system, by doing what was required by the science department, but supplementing it his own way. As an example, Zach mentioned that:

> I feel like you can cooperate. Questioning and sort of guided learning with worksheets. “Can you explain how you did that?” “Did someone else do it differently, like number 9, what did you do?” There is a good way to follow that and if they walk in [another teacher or an administrator observing him] they can see, oh, we are doing worksheets (interview 1).

Thus, Zach resolved a similar goal conflict in a different way from A.C. Whereas A.C. resolved this by withdrawing from the science department, Zach hoped to modify multiple goals to reach a state where these goals can coexist. In this case, Zach is willing to substitute worksheets for inquiry in deference to the science department and administrative expectations. At the same time, Zach is willing to modify the lessons that he is expected to teach in ways that he feels promote a more robust learning experience for his students.

Zach’s goal system at the end of the semester

At the end of the semester, Zach held the same two cognitive policies with respect to the human dimension of the school organization. The first of these was for Zach to collaborate with other members of the science department. The second cognitive policy that Zach held was to invite his principal to provide feedback on his teaching and give advice on ways to improve. I detail each below.

The first cognitive policy that Zach held was to collaborate with his science department. When asked to explain why he felt it was important to collaborate with the other teachers, Zach stated that "if they [the science teachers] are not trying to help each other out, then the students aren't getting the best that they could get [if] people were cooperating" (interview 3). For Zach, collaboration was important because it allowed for an exchange of ideas and led to a higher quality of teaching in his own classroom. Zach also felt that the exchange of ideas could go both ways, and that a collaborative atmosphere would lead the other teachers to value his input into the planning process. While Zach expected to benefit from collaboration, he also hoped that his fellow teachers would benefit from collaborating with him.

The second cognitive policy Zach held was to invite his principal to provide feedback on his teaching. Zach felt this was important because "I feel like they [the principal] would know more than me. They're giving feedback to me and everyone else, so they would see a lot of different things happening in a lot of different classrooms" (interview 3). Zach continued that "if they see something really good in [another] classroom, then their feedback to me is 'why don't you try it like this.' That's what I would like" (interview 3). Additionally, Zach suggested that he will "always look at the feedback and try and think about what can I do to actually do that" (interview 3). For Zach, the principal was a key figure as he continued to mature as a teacher.

Analysis of Zach's goal systems

Zach was the only student teacher not to disengage from a cognitive policy related to the human dimension of the school organization over the course of the student teaching semester. In both January and May, Zach hoped that he would collaborate with and be mentored by the other science teachers at his school. Zach further maintained that he wanted a principal to act in the capacity of instructional leader, providing information on how Zach can increase the effectiveness of his teaching.

Zach expressed a conflict between his pedagogical goal systems and his cognitive policy of collaborating with the other teachers in January that he no longer expressed in May. Zach indicated that he would resolve this conflict in favor of his cognitive policy related to collaborating with the science teachers. In essence, Zach was willing to reduce his use of inquiry and adopt the curriculum of the teachers he worked with, albeit with the intent to modify this curriculum in ways that he felt promoted student learning.

Kelly's goal systems related to the human dimension of the school organization

Kelly's goal system at the beginning of the semester

In January, Kelly held two cognitive policies. The first cognitive policy is her desire to collaborate with the other science teachers at her school. The second cognitive policy Kelly holds is to manage the politics of the school and science department effectively. I detail each below.

First, Kelly hopes:

To develop a relationship with them. Not [just] with the students, but with the teachers that surround me because I know that you can build one another up. You can help one another and really encourage each other in your ideas, and your planning (interview 1).

By developing these relationships, Kelly expects to collaborate on lesson plans and classroom management ideas. She also indicated that collaborating with her teachers provides an affective component of building each other up. By this, Kelly meant that she expected some days would be difficult, and that the collaborative atmosphere would provide an avenue for both venting ones frustrations as well as to develop a course for future action.

Kelly also holds the cognitive policy to collaborate on her lesson plans with the other teachers. Kelly mentions that other teachers “may have a lesson that works. Like, for years and years the students get it, just like that” (interview 1). If this is the case, Kelly hopes that she can just adopt the lesson for her classroom, and the more collaborative the department is, the more likely that will occur. Kelly adds that “I am not going to be the only chemistry teacher in the department” (interview 1), and that collaborating allows for each teacher to improve “the ideas you may have and…portraying concepts to students” (interview 1). Thus, Kelly holds the cognitive policy of collaborating with the other chemistry teachers so that not only does she improve her teaching, but that she may help other teachers improve as well.

The idea of collaborating with other teachers also stems from Kelly’s recognition that she is not yet a master of her craft. For Kelly, part of collaboration is also avoiding pitfalls that more experienced teachers have encountered over the years. For example, Kelly mentioned that if the department head “strongly advises against [a classroom activity], I think being a veteran teacher and me being the new teacher, I should heed her advice” (interview 1). This is an additional facet of the cognitive policy regarding collaboration with other teachers that A.C., Zach and Jessie did not have. While they all hoped to collaborate in an effort to increase the likelihood that they all increase their use of good practices, only Kelly expresses the desire to also avoid bad practices via the collaborative nature of her relationships.

Kelly held a second cognitive policy of managing the politics of the school as a whole and the science department specifically. Kelly mentioned the politics at the school often, referencing comments made by Tori, one of the BSU faculty members who oversaw the student teaching seminar. On the first night of the seminar, Tori mentioned that the student teachers should be politically savvy as they plan their curriculum (seminar 1). In light of this, Kelly mentioned that she expected “politics, like really understanding how to work with people and knowing that you may not always be right” (interview 1). Kelly mentioned that managing the politics of the school was important as “there is a difference between being persistent and being pushy” (interview 1). Kelly felt she can be persistent with her ideas without being pushy and angering other teachers or administrators. Kelly further mentioned that “if it’s something you really believe that will work, and it’s something you really believe in you can be persistent” (interview 1), and that “if they [another teacher or an administrator] say no now, who says that it will be no forever” (interview 1)? In other words, the more politically savvy Kelly is, the more she expects others to eventually come to value her ideas.

Kelly does mention that she may fail in her pursuit of the cognitive policy to manage the politics, particularly in a school where the department head is very influential over the direction and content of the curriculum. As Kelly describes these situations:

> Some schools, the department head is going to be like “no, this is it.” And I realize that the schools that have department heads like that, those are the most difficult to work with because they are so unwilling to budge and it gets really frustrating for other teachers (interview 1).

When asked to elaborate on the frustration related to unyielding teachers, Kelly indicated the lack of ability to collaborate with teachers and to have her voice heard as the science department creates their curriculum.

Kelly’s goal system at the end of the semester

At the end of the semester, Kelly held a single cognitive policy related to working with the other teachers at her school. Recall that Kelly had accepted a job at Private high school prior to our final conversation, and that her remarks are based upon her expectations and desires for her first year teaching at the private school. Having disengaged from the cognitive policy of managing the politics of the department, at this time, Kelly held onto only the cognitive policy of collaborating with the other science teachers, particularly the other chemistry teacher. I detail this cognitive policy below.

Kelly’s cognitive policy is to work with the other chemistry teacher at her new school. When thinking about planning for the following year, Kelly mentions that she would borrow heavily from other teachers at her school, particularly her co-chemistry teacher. “They’ve been teaching the same thing over and over again for years. I can see how it is that they teach it and then I can add…and kind of change it to fit me” (interview 3). Kelly expects to have this freedom to modify the curriculum to fit her own approach because:

> There aren't that many people [teachers in the school] and…it's just the two of you working on that curriculum. As long as you're on the same page and your students are going at a steady pace that are very similar to one another, as long as they are going parallel to one another, I think that's fine (interview 3).

The advantage to the private school, in other words, is that Kelly expects to have less of a mandate on her curriculum. Thus, she can collaborate with other teachers in an effort to work together and teach effectively, but "in the end, it's my classroom not hers" (Kelly, interview 3). In other words, Kelly has the final say over what does and does not happen in her class.

It is because of this belief that Kelly again does not have goal conflict between collaborating with other teachers and implementing her preferred pedagogical approach in her classroom. Furthermore, she expects her collaborative efforts to be more organic than other schools, where collaboration on lesson planning is required by the administration. According to Kelly:

> I feel that there will be several required meetings, just because, at the beginning, what are we going to do. We have to be on the same page. So, every once in a whole, like required check-in meetings. And, I think in terms of other meetings, I think it will be pretty organic, and just "oh, I need help on this. Like, help me, please" (interview 3).

To some extent, Kelly hopes to collaborate in order to foster a mutually beneficial relationship. While she does not feel she will be required to work with the other chemistry teacher, she hopes that they will be able to help each other out when needed.

Put another way, Kelly's desire for collaboration is not as a means to come to a consensus on what they both will do. Instead, her desire is more along the lines of a reflective partner, bouncing ideas off each other, but ultimately deciding what is best for each of their classes individually.

Analysis of Kelly's goal system

Kelly had two independent cognitive policies in January—collaborating with the other teachers and effectively managing the politics of the school. In May, Kelly had disengaged from the cognitive policy of managing politics. It is important to note that while the cognitive policy of managing politics is similar to the conflicts mentioned by A.C. and Zach, it is different in the way that they express these ideas. A.C. and Zach held cognitive policies that conflicted in such a way that it resulted in their taking into account the potential politics of the school when resolving the conflict. For Kelly, managing the politics is the cognitive policy itself. In other words, while politics results from a conflict of cognitive policies for A.C. and Zach, the cognitive policy to manage the school and department politics decreases the conflict between cognitive policies for Kelly.

Jessie's goal systems related to the human dimension of the school organization

Jessie's goal system at the beginning of the semester

At the beginning of the student teaching semester, Jessie held two cognitive policies reflective of the human dimension of the school organization. The first cognitive policy, like A.C., Zach and Kelly, is to collaborate well with the other teachers in her school. The second cognitive policy is for Jessie to please her principal. I detail each cognitive policy below.

First, Jessie hoped to foster a collaborative relationship with her other teachers. As Jessie had volunteered at JFK Middle School over the course of the past few years, she was quite familiar with the relationships between her cooperating teacher and the other science teachers. Jessie mentioned that she hoped her school had similar relationships, and that she wanted other "teachers coming in [to her classroom] and chatting and sharing ideas and stuff" (interview 1). Jessie wanted these types of relationships so that new teachers like her can take advantage of the experience of the veteran teachers. At the same time, she felt that veteran teachers might seek out fresh perspectives upon the other teachers. In Jessie's words:

> If someone's more experienced and they have a whole…they have their lesson plans down, and someone new, they [the new teacher] can be like "what did you do for this [standard]"? Things like that. And, the other way around. Like, they [the veteran teachers] might want to have a new comer's opinion (interview 1).

This type of collegial atmosphere was widespread in the science department at JFK, providing Jessie with a picture of what she hoped would be the relationships between the faculty members at her future school.

The second cognitive policy that Jessie held was to please her principal and other members of the school's administrative team. Jessie expected that her principal would be a presence in both the lesson planning processes and in observing the implementation of those lessons in her classroom. With regards to the observations, Jessie knew "if you are a first year teacher, you're going to be observed constantly" (interview 1), by the principal, assistant principal and department head. She felt it was important to take "input from whoever's observing you" (interview 1). She would further suggest that the observations look for her following the schools approach to classroom management, assessment, and lesson planning.

With regards to lesson planning, Jessie also wants to follow the lead of the principal. In discussing how involved she expect the principal to be, she refers to an instructional initiative that the principal at JFK had implemented. "The principal wants everyone to go away from direct teach, and have more centers. Just not as lecture-y" (interview 1). She would continue that "the principal has a lot to do with how teachers structure their lessons" (interview 1) at most schools. And, as mentioned previously, Jessie does not want to anger her principal by deviating from the official curriculum of the school.

Jessie's goal system at the end of the semester

At the end of the semester, Jessie still maintained the cognitive policy of collaborating with other teachers at her school. Yet, she was unable to articulate much beyond a very abstract formulation of what that would look like. Recall that prior to our final interview, Jessie accepted a teaching position at Magnet middle school for the following year. And, at the time of our interview, she was quite unsure about what the school culture was like and the degree to which teachers collaborate. Jessie did mention that she will have "a whole team of colleagues that I'll be talking to" (interview 3). She also mentioned a chair person for the magnet program that she might work with in some capacity.

Yet, the degree of formality governing the collaborative efforts was uncertain at this time. When asked exactly how the team goes about planning curriculum, she mentioned "you just, as a team, decide what's best" (interview 3). She also felt that the team she was working with was supposed to "have a kind of theme that you're covering in all of the different subject areas for each unit or whatever" (interview 3). Again, Jessie was unable to provide further detail regarding the content of the themes, how they were chosen, or the degree of integration between the subject areas.

As such, Jessie also did not provide any indication that she experienced conflict between her cognitive policies for the human dimension of the school organization and her preferred pedagogical approach. The lack of specificity in her cognitive policies leads to a lack of goal conflict. This is different from others where their cognitive policies are mutually compatible. In that case, the pursuit of one cognitive policy can lead to the attainment of other cognitive policies. In this case, Jessie did not specify her cognitive policies to a degree where conflicts may arise.

Analysis of Jessie's goal systems

Similar to the other three student teachers, Jessie's goal system in response to the human dimension of the school organization lacked structure. In January, Jessie held independent cognitive policies of collaborating with other teachers and pleasing her principal. In May, Jessie had disengaged from the cognitive policy of pleasing her principal. Furthermore, she was much less detailed in describing her cognitive policy of working with other teachers. This is similar to the changes across her goal systems: for all three domains, Jessie's goal systems saw a reduction in the number of cognitive policies and a decrease in the structure between cognitive policies.

SUMMARY OF FINDINGS

This chapter detailed the goal systems of the four student teachers with respect to three domains. The first domain explores the goal systems of the student teachers as it related to their teacher education program. Three patterns emerge in the domain of teacher education when examining the goal systems of the student teachers. First, many of the pedagogical approaches that are emphasized by the BSU teacher education program were expressed as cognitive policies. In other words, approaches such as PBI or the 5E model were cognitive policies that the student teachers intended to pursue upon entering the classroom in August of 2014. At the same time, not every approach was operationalized into a cognitive policy for these student teachers. The second pattern to emerge was that student teachers disengaged from a cognitive policy more frequently than they adapted a new cognitive policy. This translated into a goal system comprised of fewer cognitive policies for A.C., Kelly, and Jessie at the end of the semester than at the beginning. Finally, all of the student teachers goal system remained in flux, not only via a disengagement from cognitive policies, but also via a reappraisal of the means/ends relationships amongst cognitive policies within their goal systems.

The second domain explored the goal systems of the student teachers related to the systemic reform policy of Big State. Two patterns emerged across the four student teachers. First, all four student teachers held the cognitive policy to teach the BSSS. The commitment to this cognitive policy was so strong that one student teachers—Kelly—

could not envision teaching in a manner that did not adhere to the BSSS, despite her having accepted a job at a private school and her knowledge that the education policy of Big State no longer applied to her. The second pattern to emerge was that the strength of the cognitive policy to have students pass the BSBT was related to the structure of the goal systems related to systemic reform. When the student teachers held a strong cognitive policy to have students pass the BSBT, the remaining cognitive policies were often hierarchically related. When the cognitive policy to have students pass the BSBT was weaker, there was a lack of structure to the cognitive policies of the student teachers.

The third domain explored the student teachers goal systems with respect to the human dimension of the school organization. Three patterns emerge across the student teachers goal systems. First, none of the student teachers expressed their goal systems in ways indicating a hierarchical arrangement of cognitive policies. Instead, each cognitive policy was independent of the other cognitive policies in the goal system. The second pattern to emerge was all of the student teachers held a cognitive policy of wanting to collaborate with other teachers in their school and department. Third, A.C., Zach, and Jessie all held cognitive policies related to following the directives of the principal at the beginning of the student teaching semester, yet only Zach retained this cognitive policy in May.

Finally, each student teacher experienced conflict either within a goal system or across goal systems. When this occurred, the student teachers in this study would modify one or more cognitive policies to resolve the conflict. Jessie, for example, experienced a goal conflict within her pedagogical goal system, where she held two cognitive policies that when viewed independently, promoted high quality instruction. Yet, when viewed as part of a goal system, they interact in such a way that Jessie modified one of her goals, leading to her expressing her cognitive policies in ways that are both research based *and* less than ideal. With respect to the goal conflicts across goal systems, both A.C. and Zach expressed goal conflict between their pedagogical goal system and certain cognitive policies in their goal systems related to systemic reform policy. Yet, the resolved this similar conflict by modifying different cognitive policies: A.C. modifying his systemic reform cognitive policy while Zach modified his pedagogical cognitive policy.

Chapter 5: Discussion and Implications

The broad purpose guiding this study is to add to the understanding of why science teachers use certain practices and not others in their classroom. Specifically, this study sought to ascertain *the cognitive policies comprising the goal systems of student teachers of science as they reflect on and plan for their first year of teaching.* In this chapter, I discuss how findings reported in Chapter 4 add to our knowledge of the reasons teachers use certain practices and not others in their classroom. First, I provide a brief review of the main findings from Chapter 4. Next, I discuss how this study can shed light on the mismatch between a teachers ideas and practice mentioned in Chapter 1. Third, I discuss how this study adds to the growing body of research related to the influence of systemic reform policy on the practice and pedagogy of science teachers. Fourth, I discuss the findings in relationship to work on the social context of novice teachers. Finally, I provide implications for teacher educators and directions for future research.

REVIEW OF FINDINGS

Recall from Chapter 1 how those conducting research on science teachers have struggled to fully understand the continued reliance on traditional, didactic pedagogical and curricular approaches in science classes (Abell, 2008; Crawford, 2007; Fletcher & Luft, 2011). In Chapter 2, I suggested that part of the lack of understanding stems from the paucity of research on teacher’s goal representations, as distinct from belief or knowledge representations. This study provides evidence that the goal systems of teachers, and the individual cognitive policies that comprise them, may contribute to the lack of reform-oriented teaching in science classes.

Starting with the theoretical assumptions that goal representations are fundamental components of behavior and that decisions are made with respect to active goal representations, this study makes four claims regarding the cognition of science teachers leading to classroom practice.

First, *novice teachers exit teacher education having adopted cognitive policies representative of many, but not all, of the pedagogical approaches they are exposed to during their teacher education training.* The student teachers in this study, when envisioning their future classrooms, expressed pedagogical cognitive policies supportive of reform oriented teaching approaches including the use of inquiry, PBI, and the 5E model. At the same time, they did not all adopt all of these approaches. Thus, in answering the question of why science teachers do not use certain practices emphasized in their classroom, part of the answer may be due to a lack of integration of such approaches into their goal representations.

Second, *over the course of the student teaching semester, student teachers are much more likely to disengage from a cognitive policy than they are to adopt new cognitive policies.* With respect to the goal systems of the four student teachers, only Zach adopted more cognitive policies than he disengaged from over the semester. Furthermore, neither A.C. nor Kelly added a single cognitive policy to their goal systems over the course of the semester. This provides evidence for the claim that goal representations are distinct from knowledge and belief representations, as these student teachers did not "forget" the cognitive policies in the sense that they no longer had knowledge of the existence of these pedagogical approaches. Thus, in answering why teachers do what they do, this sheds light on why they may choose not to do something: for some reason, they have disengaged from a cognitive policy.

Third, *the goal systems of student teachers are comprised of pedagogical cognitive policies reflective of their teacher education training and cognitive policies created in response to broader aspects of the school organization.* In other words, these teachers also hold goals related to their being employees of the school, district and state in which they work. Furthermore, choice and decision making are fundamentally tied to the goals one is trying to satisfy (Markman, et al., 2000). Thus, the decisions made while lesson planning are reflective of currently active goal representations and potential avenues toward attaining such desired outcomes. And, the currently active goals will influence the value of specific classroom approaches. Again, responding to “why teachers do what they do when they teach science” (Tobin & McRobbie, 1999, p. 215), part of the answer comes from recognizing the complexity of the goal systems of science teachers and realizing that while often they are pursuing a cognitive policy related to effective pedagogy, other times cognition is driven by a cognitive policy related to other aspects of the school organization. In cases where decisions are made relative to cognitive policy related to the school organization, pedagogical approaches emphasized in teacher education may appear less appealing.

Finally, *at times, the multitude of cognitive policies teachers hold come into conflict, requiring either the modification or disengagement from one or more cognitive policies.* The student teachers in this study often disengaged from their pedagogical cognitive policies—although I cannot claim this was due to goal conflict, as there are other causes for goal disengagement reported in the literature. There is ample evidence that these student teachers modified their pedagogical cognitive policies when a conflict arose with respect to other cognitive policies. In some cases, the modification favored their pedagogical goal systems, requiring a modification of their cognitive policies related to the other domains. In other cases, however, these student teachers made modifications to their pedagogical cognitive policies. Most interestingly, however, might be the conflict that Jessie experienced within her pedagogical goal system: her cognitive policy of preventing misconceptions resulted in a modification of her cognitive policy to teach through inquiry. Again, in response to the question of why science teachers use certain practices and not others, the role of goal conflict suggests that, as Kennedy (2005) also mentions, teachers are pursuing multiple cognitive policies at a given time, and their classroom choices often reflect modifications such that they can achieve some degree of success for each cognitive policy.

INCONSISTENCY BETWEEN MEDIATING STATES AND PRACTICE

There is a well-documented inconsistency between the pedagogical approaches that science teachers self-report they pursue and the observed practice within their classrooms. While teachers may report having reform oriented beliefs and knowledge, they tend to implement traditional approaches to teaching science in their classroom (Abell, 2008; Banilower, Smith, Weiss, & Pasley, 2006; Crawford, 2007; Davis, et al., 2006; Jones & Leagon, 2014; Kang & Wallace, 2004; Luft & Roehrig, 2007; Simons, et al., 1999; Van Driel, et al., 2014; Webel & Platt, 2015). Because "teachers' professed beliefs—usually captured via self-report—often prove, for a variety of reasons, relatively unreliable as indicators of actual behavior" (Anderson & Stillman, 2013, p. 35) it is assumed that the social desirability bias is responsible for this paradox, where teachers do not self-report their actual beliefs, but instead report the beliefs that they assume researchers want to hear (Craig, 2006; Deemer, 2004; Fang, 1996; Gill & Hoffman, 2009; Kagan, 1990). The social desirability bias is a popular solution to this paradox when models of teacher cognition assume a direct relationship between the mediating states of teachers and their classroom practice (Crawford, 2007; Enderle, et al., 2014; Roehrig, et al., 2007; Wallace & Kang, 2004)

Like others such as Woodbury and Gess-Newsome (2002), I depart from the assumption that there is a direct relationship between mediating states, including beliefs and knowledge, and practice. I also suggest the relationship is more complex—a full understanding of teachers' classroom practice must take into account the goal representations of teachers. This study treats beliefs and knowledge as separate representations from goals and cognitive policies. One can hold a belief in and knowledge of a specific pedagogical approach without integrating that approach into their goal systems.

What do the goal systems presented in Chapter 4 tell us about the future classrooms of these four teachers? If, as suggested by Kennedy (2006b): (1) teachers "plan their lessons by envisioning them unfolding as a drama might" (p. 205); (2) that these visions are simulated with respect to their goal representations; and (3) there is a strong degree of congruence between the visions for their classroom when planning and the actual goings on of their classes, then the goal systems of the student teachers imply the pedagogical practices these student teachers will pursue upon entering the classroom. Furthermore, it tells us that despite knowing about and believing in certain pedagogical approaches, if a teacher does not adopt cognitive policies regarding those approaches, they will not mentally simulate their visions for teaching with respect to those pedagogical approaches. And, they will not pursue them in their future classes.

This provides an additional answer to the belief-practice inconsistency paradox. While it is possible that the paradox arises from the social desirability paradox, it is also possible that it arises from a failure to operationalize beliefs or knowledge into a cognitive policy as part of the broad goal systems that teachers have. Put more simply, *the belief-practice inconsistency may arise due to a lack of goal adoption, and not due to the social desirability bias.*

Goal systems and goal conflict

While treating goals and beliefs as overlapping mental constructs, Webel and Platt (2015) nonetheless investigated the goals of two mathematics teachers, finding an apparent goal-practice inconsistency. They further suggest that if they were to view the goals of teachers in isolation, one "might question whether they really held the goals they espoused at the beginning of the year, and we might see their teaching as evidence that these goals were not accurate representations of their true intentions" (Webel & Platt, 2015, p. 213). Instead, Webel and Platt (2015) suggest that viewing goals in isolation is problematic, as teachers hold a multitude of goals, any of which might be influencing the practice of a teacher at a given time. While separating goal representations from belief representations, I also adopt a theoretical approach suggesting individual goal representations are part of a larger goal system, similar to the approach of Webel and Platt (2015).

This approach is also congruent with the consensus that teacher beliefs are not isolated from each other, but instead exist in belief systems (Belo, et al., 2014; Crawford, 2007; Jones & Leagon, 2014; Lotter, Hardwood, & Bonner, 2007; Verjovsky & Waldegg, 2005). These researchers also suggest that viewing beliefs as isolated constructs can lead to erroneous conclusions, and emphasize the necessity to understand both the "content and structure" (Belo, et al., 2014) of teachers beliefs. This study extends that notion, suggesting that teachers' goal representations also exist in structured systems. The results in Chapter 4 include not only the content of the cognitive policies of teachers, but also the structural relationship between individual cognitive policies.

There is an emerging notion within the research on teachers' belief sets suggesting that teachers hold competing or conflicting belief sets (Bryan, 2003; Crawford, 2007; Davis, et al., 2006; Haney & McArthur, 2002; Jones & Leagon, 2014; Wallace & Kang, 2004; Webel & Platt, 2015). In a review of research on novice science teachers, Davis and colleagues (2006) found ample evidence that "teachers hold some beliefs that—when put into practice—conflict with other beliefs. When this happens, one belief may trump another, sometimes leading to less sophisticated teaching practices" (p. 625). This study, like the work of Webel and Platt (2015) with mathematics teachers, extends the notion of conflict between representations of science teachers to goal systems, providing evidence for goal conflict both within and across goal systems.

The notion of goal conflict both within and across goal system provides an additional solution to the belief-practice inconsistency paradox. Traditional approaches to studying teacher cognition would investigate the content of the pedagogical goal systems of teachers and then measure the degree to which their practice was (in)consistent with their espoused approach to teaching science. This study takes a different approach, suggesting conflict within and between goal systems can lead to a resolution that pushes teachers to enact practice at odds with their pedagogical beliefs and goals when viewed in isolation. It is certainly possible that classroom practice is the result of a single cognitive policy driving cognition. At the same time, classroom practice may also result from the resolution of a conflict between multiple cognitive policies. Thus, it is possible that goal conflict, and not social desirability bias, may also contribute to the inconsistency between what teachers self-report and their observed classroom practice.

THE IMPACT OF SYSTEMIC REFORM POLICY

There is considerable interest on the impact that the current wave of accountability policy has on teachers and students in science. Furthermore, there is some question as to the impact of state standards and high-stakes assessments—the two foundational elements of systemic reform—have on science teachers. Some suggest that "testing drives pedagogy" (Burley & Morgan-Fleming, 2008, p. 16), and as such, schools and teachers adopt pedagogical and curricular approaches that prepare students for passing the end of year assessments at the expense of more rigorous, reform oriented approaches (Anderson, 2012; Firestone & Schorr, 2004; Haney & McArthur, 2002; Penuel, at al., 2008; Planck & Condliffe, 2013). Others suggest that science teachers are “more apt to support standards as guidelines for instruction than the standards-based assessments that accompanied them” (Donnelly & Sadler, 2009, p. 1069), thereby responding favorably to and adapting practice reflective of state standards. While recognizing the influence of both standards and testing on science classroom practice, this study suggests that standards may play the larger role in the pedagogical decision making of novice teachers.

The influence of the state standards may be so strong that even those teachers who, like Kelly, do not enter traditionally governed public schools still define their content via appeal to the standards and adopt this as part of their goal systems. This is congruent with research by Brown (2010) who remarks on the taken-for-granted assumption of preservice teachers that standards define the content to be taught. As Brown (2010 mentions, the majority of current undergraduate teacher education students entered the public K-12 education system after the passage of *No Child Left Behind*, the Federal legislation codifying systemic reform as part of federal education policy. As with the students in Brown’s (2010) study, the four student teachers in this study have an “understanding that their role as classroom teachers [is] to implement the state’s mandated curriculum, [the BSSS]” (Brown, 2010, p. 483). This may be particularly important as many states, including Big State, begin to roll back the number of tested grades and subjects. In these states, it may be the standards documents, and not high stakes tests, that drive pedagogy.

Goal conflict and systemic reform

The conflict between reform-oriented pedagogical approaches and systemic reform policy is congruent with much work on preservice and in-service teachers. There are numerous studies documenting the incompatibility of reform-oriented approaches with the current accountability regime (Achinstein, et al., 2004; Anderson, 2012; Aydeniz & Southerland, 2012; Donnelly & Sadler, 2009; Saka, et al., 2009; Settlage & Meadows, 2002; Shaver, et al., 2007; Taylor, et al., 2008). This study adds to and extends these findings in three ways. First, it extends the finding of incompatibility to the goal systems of teachers. Previous research has found that teachers believe the systemic reform policy and reform-oriented teaching approaches are incompatible (Anderson, 2012). Other research has shown the curricular materials that districts adopt, such as text books, are also incompatible with reform-oriented science teaching (Fishman & Krajcik, 2003; Kesidou & Roseman, 2002; Munby, Cunningham & Lock, 2000). Using the language of the superordinate theory of representation guiding this study, previous work has shown that the conflict between systemic reform policy and reform-oriented science teaching (AAAS, 1990; NRC, 1996; 2000; 2012) exists in both the mediating states of teachers and the contexts that supply environmental states to teachers. This work adds to that, suggesting that all three representational elements are parties to the incompatibility of reform oriented teaching and systemic reform policy.

Second, this study extends the literature on the incompatibility of reform oriented science teaching and systemic reform via the finding that the conflict across goal systems arose during the student teaching semester. As mentioned above, as the central tenets of systemic reform policy—standards and testing—have become so normalized in the K-12 education experience of current preservice teachers, they do not perceive a conflict between their goal systems until they gain extended classroom experience.

The third way this study adds to work on the incompatibility of systemic reform policy and reform oriented science teaching is via a recognition that the incompatibility exists for those teachers who do not teach tested subjects. In other words, a teacher who is not burdened by the presence of state-level exams may be impacted by systemic reform policy in other ways. Again, this may be of particular importance as states begin to roll back the number of courses that are subject to their high-stakes tests.

ENTERING THE SCHOOL COMMUNITY

As Ingersoll (2003) reminds us, teachers no longer work in isolation. Instead, they are members of school and department communities, both of which influence teaching and learning of science. Previous studies have shown that the school and departmental culture have a profound impact on the practice that novice teachers adopt in their first years of teaching (Anderson & Helms, 2001; Carlone, 2003; Kauffman, et al., 2002; McGinnis, et al, 2004; Saka, et al., 2009; 2013; Windschitl & Sahl, 2002). There is considerable variance in the degree to which school culture is supportive of novice teachers and the reform oriented practices they hope to implement in their science classes. Research from both McGinnis and colleagues (2004) and Saka and colleagues (2009) found some schools within their studies were supportive of their novice teachers, while other schools had cultures adding to the constraints novice teachers faced in their attempts to implement reform oriented teaching practice.

Not only is there variance in the degree of support that schools offer, there is also variance in the degree with which novice teachers welcome support. At one end, there are those who find, similar to Saka and colleagues (2009; 2013), novice teachers who consistently reject any attempts at mentoring and induction support from the other teachers at their school. On the other end, Kauffman and colleagues (2002) worked with a group of novice teachers whom "entered the classroom expecting to find a curriculum with which they would struggled. Instead, they struggled to find a curriculum" (Kauffman, et al., 2002, p. 291). In other words, the teachers in Kauffman and colleagues' (2002) study actively sought curricular guidance from and were let down by their school and department communities. This study is more aligned with findings such as those of Kauffman and colleagues (2002), as all the student teachers in this study held cognitive policies to collaborate with their colleagues in the science departments of their future schools.

This study adds to the work on the relationship between novice teachers, the school culture, and classroom practice in an interesting way. While these student teachers wanted to collaborate with their colleagues, they also expected many of their future colleagues to prefer more traditional pedagogical and curricular approaches to their science teaching. If hired into more traditional schools, novice teachers are forced to strike a balance between their goal systems reflective of their professional training and their goal systems related to their membership in the school community.

The resolution of this conflict adds to our understanding of the difficulties novice teachers can face during their early school experiences. Echoing the work of Saka (Saka, et al., 2009; 2013), teachers like A.C. may resolve this conflict via a modification of the cognitive policy to work with the science department. This sheds additional light on the work of Saka and colleagues (2009; 2013), as it may not be an outright rejection of the school, but a stronger commitment to goal systems reflective of the methods novice teachers developed in teacher education. In other words, some novice teachers may reject the school culture when faced with a choice between adhering to their professional training and accepting the status quo of their science department.

Other teachers may resolve the conflict by modifying their pedagogical cognitive policies, and supplementing the curriculum that was promoted by the science department in ways that reflected his teacher education program. For these teachers, like Zach, the resolution is to adopt the curriculum favored by the other science teachers while increasing the rigor of the assignment in ways that reflected their pedagogical cognitive policies, such as asking thought provoking questions. This echoes the desires of the novice teachers in the study by Kauffman and colleagues (2002), who hoped to find a curriculum that they could modify in ways that were congruent with the research based methods they learned in teacher education. Neither the students in the Kauffman study (Kauffman, et al., 2002) nor Zach wanted to create curriculum from scratch, and thus adopted an approach of modifying the curriculum currently used by the teachers in their school.

The final way that teachers can resolve this conflict, exemplified by Kelly, and to my knowledge unreported in the literature, is via the adoption of an additional cognitive policy: managing the politics of the science department. By playing politics, teachers such as Kelly can implement their preferred pedagogical approach without appearing to disregard the approach that the more experienced teachers in the science department favored. This can be seen as the middle ground to the approaches exemplified by A.C. and Zach. Unlike the resolution for A.C., Kelly in unwilling to withdraw from the school community. Unlike the resolution for Zach, Kelly is also less willing to disengage from or modify her pedagogical cognitive policies.

IMPLICATIONS FOR TEACHER EDUCATION

There are several implications for teacher education that arise from this study. First, there is ample evidence that many first year teachers disregard the reform oriented pedagogical approaches emphasized in their teacher education program for more traditional curricular approaches (Davis, et al., 2006; Fletcher & Luft, 2011; Luft, et al., 2007). Often, it is assumed the apprenticeship of observation proved far too difficult to overcome. Thus, teacher educators need to redouble their efforts promoting conceptual change of preservice science teachers (Berry & Van Driel, 2013; Loughran, 2006; Luft, et al., 2011). This study suggests a different potential cause and response. This study suggests that a failure to emphasize the creation of cognitive policies may contribute to the lack of reform-oriented practice in the classroom. All of the student teachers, for example, knew of the 5E model and believed that it was effective. Yet, this did not necessarily translate into the cognitive policy to use the 5E approach. The first implication from this study is that *teacher educators need to engage in efforts to help preservice science teachers integrate cognitive policies reflecting reform oriented teaching practice into their goal systems.*

Additionally, all four student teachers disengaged from at least one pedagogical cognitive policy between January and May. Over the course of the student teaching semester, A.C., Kelly, and Jessie also experienced decreases in the total number of pedagogical cognitive policies comprising their goal system. The disengagement from and decrease in number of cognitive policies may only exacerbate the likelihood of reverting to traditional pedagogical approaches upon entering the classroom, especially if a student teacher only has a small number of reform-oriented pedagogical cognitive policies to begin with. The second implication arising from this work is *during the student teaching semester, preservice science teachers need to be supported in ways that they are likely to maintain their pedagogical cognitive policies.* This implication is supported by work from teacher induction studies (Luft, 2009; Luft, Roehrig, & Petterson, 2003; Wang, Odell, & Schwille, 2008) suggesting targeted, science specific support increases the likelihood of using the methods learned during teacher education, thereby reducing the belief-practice gap.

A third implication arising from this work comes from the goal conflict expressed both within and across goal systems. All four student teachers expressed a conflict potentially preventing the successful attainment of a pedagogical cognitive policy. Of the four, only A.C. did not modify his pedagogical cognitive policies in response to conflict with other aspects of his goal system. The other three student teachers all expressed a desire to modify their reform oriented approaches in light of the conflict. The third implication from this study is *teacher educators should help teachers resolve goal conflicts in productive ways.* For teachers like Zach, Kelly, and Jessie, the implication is given the presence of goal conflict, teacher educators can and should help teachers at all levels of their careers resolve them in a way favoring the implementation of reform oriented classroom practice.

This implication also extends to teachers like A.C., who are so strongly committed to their pedagogical goal systems that they are willing to withdraw from the school and department community. While these teachers should be commended for their commitment to the reform oriented strategies learned in teacher education, the resolution of the conflict with the other cognitive policies leaves something to be desired. As stated previously, this echoes to work by Saka and colleagues (2009; 2013) who found a detrimental impact on both the classroom practice and emotional wellbeing of a first year teacher who withdrew from the school and science department communities. In this light, approaches like the one taken by A.C. to this goal conflict are likely not a productive resolution. Instead, teachers like A.C. should be mentored to resolve this goal conflict in ways that promote reform-oriented practice without isolating them from their science department.

This leads into the fourth implication, *teacher education programs should include the development of Shulman's knowledge base regarding knowledge of schools into their formal curriculum.* Along with Calabrese Barton (2007) and Southerland and colleagues (2011), this work suggests that a teacher education program that focuses on a subset of the knowledge bases of Shulman (1987) at the expense of others is not sufficient to achieve the vision of reform contained in reform documents (AAAS, 1990; NRC, 1996; 2000; 2012). Furthermore, this study suggests that developing the knowledge of educational contexts (Shulman, 1987) may lead to more productive resolution of goal conflict. While A.C., Zach and Kelly all expressed similar goal conflicts, only Kelly resolved this conflict in a productive way: via the adoption of the additional cognitive policy to effectively manage the politics of the school she would be working at. In other words, due to knowledge of the social and political aspects of working in a school, Kelly was able to resolve this conflict in the most productive ways.

The final implication arising from this study reflects the cognitive policy of teaching the BSSS. As mentioned previously in this chapter, there is some debate as to the mechanism by which systemic reform policy—often embodied as part of broader accountability policies—leads to reductionist pedagogy in science classrooms. This study suggests that state standards may play a larger role in the classrooms of novice teachers. Each student teacher held a cognitive policy throughout the student teaching semester reflective of teaching the BSSS. Kelly and Jessie held this cognitive policy despite the absence of or reduction in the pressure to have students pass the BSBT. Thus, the final implication arising from this study is *teacher educators need to recognize the role state standards play in the goal systems of novice teachers and help them resolve potential conflicts between standards and reform-oriented pedagogy in ways supportive of the use of reform-oriented practice in their classroom.*

DIRECTIONS FOR FUTURE RESEARCH

Broadly speaking, this study is part of a larger effort to more fully understand what science teachers do in their classrooms (Abell, 2008; Crawford, 2007; Kennedy, 2005). More specifically, this study has suggested new insights into the long-standing belief-practice inconsistency paradox may be found by treating goal representations as distinct from and equal in importance to mediating states, such as beliefs and knowledge, and environmental states. Throughout this study, I have made the conjecture that the belief-practice inconsistency paradox results from either science teachers not integrating reform-oriented practices into their goal systems or from the conflict between their pedagogical goal systems and goal systems related to other aspects of the school organization. This study is a first step in that direction. However, for reasons detailed in Chapters 3 and 4, I did not compare the goal systems of student teachers to their practice in their student teaching classroom. Therefore, the first and most important direction for future research is to investigate the practice of novice science teachers as it relates to their goal systems. In other words, is there consistency between classroom practice and any of the cognitive policies they hold?

A related avenue for future work is the study of teachers who implement, to even a small degree, reform-oriented practices in their classroom. What are the cognitive policies that teachers who do use reform oriented practices pursue in their classes? How are those similar to or different from the goal systems and cognitive policies of both novice teachers and those teachers who favor more traditional approaches? Do they exhibit goal conflict and if so, how are their conflicts resolved in productive ways? Insights from this line of work can aid teacher educators who make the development of reform-oriented goal systems a priority in their teacher education courses.

A third avenue for research comes from recognizing the three domains explored in Chapter 4 are not the only domains for which preservice, novice, and experienced teachers have goal systems. For example, this study did not explore the degree to which issues of equity are represented in the goal systems of student teachers. Furthermore, how do issues of equity interact with the other domains of the student teachers' goal systems? Are there conflicts that lead novice teachers astray from the reform-oriented practices they learned in teacher education?

Finally, future research should examine the student teaching semester more fully. This study asked student teachers about the cognitive policies they hoped to pursue during their first year teaching. However, I did not "open the 'black box' of field experience and document the mechanisms at play in field experience and how those mechanisms interact (or fail to interact) with concomitant experiences in teacher education courses" (Rozelle & Wilson, 2012, p. 1197). Within the context of this study, the black box refers to both the *goal systems for student teaching* and *how student teaching influenced the goal systems for the first year of teaching.* With respect to the first aspect of the black box, this line of research would investigate the degree to which the goal systems of student teachers aid in their navigation of the two worlds and what they hope to accomplish during the student teaching semester.

Research arising from the second avenue of opening the black box of student teaching would seek to more fully understand the development of the goal systems for the first year of teaching during the student teaching semester. Broadly speaking, this line of research would investigate the aspects of student teaching that influence student teachers in their maintenance or disengagement from cognitive policies reflective of reform-oriented teaching practice. There is, for example, a large body of research that suggests feedback on successful attainment of goal pursuit is paramount to continued adherence to long-term cognitive policies (Custers & Aarts, 2005; Finkelstein & Fishbach, 2012; Laran & Janiszewski, 2009; Moskowitz, 2012; Sheeran & Webb, 2012). This feedback can be due to self-reflection (i.e. reflecting on the successes of a particular lesson as well as areas for improvement) as well feedback provided by others (i.e. feedback on observations from a cooperating teacher). This implies that part of the change in goal systems exhibited by A.C., Zach, Kelly, and Jessie may be due to the feedback they received and their own self-reflection.

CONCLUSION

As mentioned in chapter one, this project serves as the entry into a research program that seeks to more fully understand the relationship between the goal systems of science teachers and their classroom practice. The results presented here provide intriguing evidence that goal representations, as distinct from beliefs and knowledge, are an important part of the cognitive puzzle that has yet to be fully pieced together. Yet, this is only the first step. More work on the goal systems of science teachers at all stages in their careers is needed if we are to more fully understand why science teachers teach in the manner that they do.

Appendix A: BSU Student Teaching Semester Syllabus

BSU STUDENT TEACHING
FIELD EXPERIENCE SYLLABUS

COURSE EXPECTATIONS

- Spend a minimum of four hours every day on the assigned campus.
- Teach two class periods autonomously for at least 12 weeks.
- Submit lesson plans in advance to *BSU* Instructors and Cooperating Teacher and revise as requested.
- Demonstrate proficiencies in teaching and obtain documentation through observations and reflections.

COURSE GRADE (CONTINGENT UPON TEACHING SPECIFIED NUMBER OF DAYS IN THE SCHOOL)

A passing grade in this course requires:

- Teaching the specified number of days in the school
- Completion of the Mid-Semester Evaluation
- Completion of the Final Evaluation with "Competent" scores
- Successful Completion of the *BSU* Final Portfolio

This course uses resources provided by *BSU* and you will likely CHECK OUT items for use outside of the classroom. You are responsible for all items in your care and must return them in a timely fashion. Failure to do so may result in financial bars.

Big State University provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at ###-###

Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University Extension program or The University. Since such dishonesty harms the individual, all students, and the integrity of The University, policies on scholastic dishonesty will be strictly enforced. For additional information regarding this policy, please refer to the most current General Information booklet.

BSU APPRENTICE TEACHING
SEMINAR

COURSE DESCRIPTION

BSU Apprentice Teachers simultaneously take this seminar with the six hour *Field Experience* course. Course objectives and activities are aligned with the State Board for Educator Certification's Learner Centered Proficiencies, the standards for all new teachers in *Big State*. The Apprentice Teachers demonstrate that they meet the state standards by preparing and submitting a final portfolio. Course activities also aid Apprentice Teachers in preparing for the *Big State Certification* examinations.

COURSE OVERVIEW

Class meets once a week on campus for 1 1/2 hours. In a supportive environment Apprentice Teachers share their experiences and work on solutions for difficulties they are experiencing. They learn about legal and logistical issues in teaching, become familiar with how the diverse components of a high school or middle school are organized into a highly effective system, and prepare for the *Certification* Exam. For their final product, Apprentice Teachers submit a portfolio, which documents their progress toward meeting the State Board for Educator Certification standards for new teachers.

COURSE OBJECTIVES (from the State Board for Educator Certification standards)

After completing this course Apprentice Teachers will be able to:

- Design instruction appropriate for all students that reflects an understanding of relevant content and is based on continuous and appropriate assessments.
- Create a classroom environment of respect and rapport that fosters a positive climate for learning, equity, and excellence.
- Promote student learning by providing responsive instruction that makes use of effective communication techniques, instructional strategies that actively engage students in the learning process, and timely high-quality feedback.
- Fulfill professional roles and responsibilities and adhere to legal and ethical requirements of the profession.

COURSE EXPECTATIONS

- Attend all class sessions.
- Participate in class discussions and activities.
- Complete all assignments by the designated dates. Assignments should be:
    - Content Accurate
    - Grammatically Correct
    - Aligned with Appropriate Rubrics
- Complete and pass the final portfolio.

COURSE GRADE

35% FINAL PORTFOLIO (SUBMITTED BY THE DEADLINE WITH A PASSING SCORE)
30% ELECTRONIC REFLECTIONS WITH EVIDENCE ON PORTFOLIO PROFICIENCIES, WEEKLY LESSON PLANS
15% ATTENDANCE AND PARTICIPATION IN SEMINAR AND SUCCESSFUL COMPLETION OF ALL IN-CLASS ASSIGNMENTS
10% COOPERATING TEACHER SCHEDULE
10% TIME CAPSULE WITH FUTURE ADDRESS

ALL LATE WORK, INCLUDING ATTENDANCE, WILL BE ASSESSED A PENALTY OF HALF-OFF THE DESIGNATED CREDIT UNLESS IT IS LATER THAN ONE WEEK OF THE DUE DATE, IN WHICH CASE NO CREDIT WILL BE GIVEN.

This course uses resources provided by *BSU* and you will likely CHECK OUT items for use outside of the classroom. You are responsible for all items in your care and must return them in a timely fashion. Failure to do so may result in financial bars.

BSU provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at *Phone Number*.

Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University Extension program or The University. Since such dishonesty harms the individual, all students, and the integrity of The University, policies on scholastic dishonesty will be strictly enforced. For additional information regarding this policy, please refer to the most current General Information booklet.

Appendix B: Initial Interview Protocol for Main Participants

Interview Protocol: Initial Interview with Participants

General Pedagogical Questions

1. What subject do you plan to teach when you graduate? Why do you want to be a (biology/chemistry/physics) teacher?
2. What is the best approach to teaching that subject? What makes a (subject) teacher effective? How do they know if they are successful?
3. Think back to when you were in middle/high school. Is this how your science teachers approached your classes? Tell me about some of the science teachers who stand out most in your mind. What was their approach to teaching science?
4. Tell me about your BSU classes. What courses did you take? Who were your professors? What things stand out from your BSU classes? Tell me about your field experiences? What things stand out from your field experience?
5. What content courses have you taken? Do you think these will be useful as a teacher? If so, how so? If not, why not?
6. What kind of content is included in the class you will teach? What are the most important concepts?
7. Why do you think students need to learn science in general? Your subject specifically? What about students who don't enter STEM fields? Don't go to college? What do you hope your students learn after they have you for a teacher?

General Organizational Questions

8. Imagine the school you will teach at your first year teaching. What will the school be like?
    a. Describe your typical class period, from bell to bell. What activities will you do?

b. Describe your typical day? What sorts of things do teachers do? What do you do during your off period?
c. What will the students be like? What will their post-grad plans be?
d. How do you think you will interact with the other teachers in your department? What does the department head do?
e. Who decides what content you should teach?
f. What do you think your relationship with your principal will be like? What is their role in your classroom? What is their role for the entire school?

9. How do others determine if teachers are effective? How does your principal? How do other teachers? How do students? Parents? Districts?
10. How do we know if a school is effective?

Student Teaching Specific Questions

11. What do you know about the school you will student teach at? What kinds of students attend that school? Is the school a "good school"? How do you know?
12. Do you know what subject/courses you will be teaching? What kinds of content will you cover in that course? Do you have activities/lessons that you want to do?
13. Is the school you will be student teaching at similar to the school you envision yourself teaching at next fall? How are they similar/different?

Background Information

14. What is your age/gender/ethnicity?

Appendix C: Interview Protocol for Seminar Faculty

Interview Protocol: University Faculty

General Background Questions

1. Tell me about your teaching experience? How long were you a teacher prior to coming to UT? What courses did you teach? What kinds of schools did you work at? Did you teach in Austin? If not, where?
2. Tell me about your teaching preparation. What was your undergrad degree in? What was your teacher education program like? Do you have any graduate degrees? If so, in what areas?
3. How long have you been a Master Teacher? What other courses have you worked with at BSU?
4. Have you had any professional roles in education besides teaching and working as a master teacher (i.e. district curriculum specialist, employee of the state, etc.)?

Questions on Student Teaching

5. Describe the UT student teaching semester. What are the objects or goals of the experience? Do students have assignments? What do student teachers need to do in order to successfully complete their student teaching assignment?
6. How does the weekly seminar support these objectives?
7. What is your teaching philosophy regarding the student teaching semester? What do you want students to learn over the course of the semester? Is this different from the formal objectives that BSU sets?
8. What kind of feedback do you give students when you observe them teach?

Appendix D: Interview Protocol for Cooperating Teacher

Interview Protocol: School Based Participants (i.e. Cooperating Teacher, etc.)

General Background Questions

1. How long have you been a teacher? What subjects have you taught? What schools have you taught at?
2. What was your teacher education program like?
3. Describe your general teaching philosophy? Why do students need to learn science? Your specific content?
4. Describe a typical class period for me. What do you do? What do students do?

For student Teaching Semester

1. What do you hope that your student teacher learns over the course of the semester? What is important to understand over the course of the student teaching experience?
2. How do you define your role, in order to bring about that learning?
3. How much freedom do you give to a student teacher for things such as classroom management, curriculum, planning, etc.?
4. Do you require your student teacher to attend any other school activities, meetings, etc., outside of teaching your class? Why or why not?

Appendix E: IRB Approval

OFFICE OF RESEARCH SUPPORT

THE UNIVERSITY OF TEXAS AT AUSTIN

P.O. Box 7426, Austin, Texas 78713 · Mail Code A3200
(512) 471-8871 · FAX (512) 471-8873

FWA # 00002030

Date: 12/16/13

PI: Todd L Hutner

Dept: Curriculum and Instruction

Title: Early Career Teachers Organizational Learning and Pedagogical Decision Making

Re: IRB Expedited Approval for Protocol Number 2013-10-0057

Dear Todd L Hutner:

In accordance with the Federal Regulations the Institutional Review Board (IRB) reviewed the above referenced research study and found it met the requirements for approval under the Expedited category noted below for the following period of time: 12/13/2013 to 12/12/2014. *Expires 12 a.m. [midnight] of this date.* If the research will be conducted at more than one site, you may initiate research at any site from which you have a letter granting you permission to conduct the research. You should retain a copy of the letter in your files.

Expedited category of approval:

☐ 1) Clinical studies of drugs and medical devices only when condition (a) or (b) is met. (a) Research on drugs for which an investigational new drug application (21 CFR Part 312) is not required. (Note: Research on marketed drugs that significantly increases the risks or decreases the acceptability of the risks associated with the use of the product is not eligible for expedited review). (b) Research on medical devices for which (i) an investigational device exemption application (21 CFR Part 812) is not required; or (ii) the medical device is cleared/approved for marketing and the medical device is being used in accordance with its cleared/approved labeling.

☐ 2) Collection of blood samples by finger stick, heel stick, ear stick, or venipuncture as follows: (a) from healthy, non-pregnant adults who weigh at least 110 pounds. For these subjects, the amounts drawn may not exceed 550 ml in an 8 week period and collection may not occur more frequently than 2 times per week; or (b) from other adults and children2, considering the age, weight, and health of the subjects, the collection procedure, the amount of blood to be collected, and the frequency with which it will be collected. For these subjects, the amount drawn may not exceed the lesser of 50 ml or 3 ml per kg in an 8 week period and collection may not occur more frequently than 2 times per week.

☐ 3) Prospective collection of biological specimens for research purposes by non-invasive means. Examples:
(a) Hair and nail clippings in a non-disfiguring manner.

(b) Deciduous teeth at time of exfoliation or if routine patient care indicates a need for extraction;
(c) Permanent teeth if routine patient care indicates a need for extraction.
(d) Excreta and external secretions (including sweat).
(e) Uncannulated saliva collected either in an un-stimulated fashion or stimulated by chewing gumbase or wax or by applying a dilute citric solution to the tongue.
(f) Placenta removed at delivery.
(g) Amniotic fluid obtained at the time of rupture of the membrane prior to or during labor.
(h) Supra- and subgingival dental plaque and calculus, provided the collection procedure is not more invasive than routine prophylactic scaling of the teeth and the process is accomplished in accordance with accepted prophylactic techniques.
(i) Mucosal and skin cells collected by buccal scraping or swab, skin swab, or mouth washings.
(j) Sputum collected after saline mist nebulization.

☐ 4) Collection of data through non-invasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications).
Examples:
(a) Physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy.
(b) Weighing or testing sensory acuity.
(c) Magnetic resonance imaging.
(d) Electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography.
(e) Moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual.

☐ 5) Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for non-research purposes (such as medical treatment or diagnosis).
Note: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(4). This listing refers only to research that is not exempt.

[X] 6) Collection of data from voice, video, digital, or image recordings made for research purposes.

[X] 7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.
Note: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.

[X] Use the attached approved informed consent document(s).

☐ You have been granted a Waiver of Documentation of Consent according to 45 CFR 46.117 and/or 21 CFR 56.109(c)(1).

☐ You have been granted a Waiver of Informed Consent according to 45 CFR 46.116(d).

Responsibilities of the Principal Investigator:

1. Report immediately to the IRB any unanticipated problems.

2. Submit for review and approval by the IRB all modifications to the protocol or consent form(s). Ensure the proposed changes in the approved research are not applied without prior IRB review and approval, except when necessary to eliminate apparent immediate hazards to the subject. Changes in approved research implemented without IRB review and approval initiated to eliminate apparent immediate hazards to the subject must be promptly reported to the IRB, and will be reviewed under the unanticipated problems policy to determine whether the change was consistent with ensuring the subjects continued welfare.

3. Report any significant findings that become known in the course of the research that might affect the willingness of subjects to continue to participate.

4. Ensure that only persons formally approved by the IRB enroll subjects.

5. Use only a currently approved consent form, if applicable.
Note: Approval periods are for 12 months or less.

6. Protect the confidentiality of all persons and personally identifiable data, and train your staff and collaborators on policies and procedures for ensuring the privacy and confidentiality of subjects and their information.

7. Submit a Continuing Review Application for continuing review by the IRB. Federal regulations require IRB review of on-going projects no less than once a year a reminder letter will be sent to you two months before your expiration date. If a reminder is not received from Office of Research Support (ORS) about your upcoming continuing review, it is still the primary responsibility of the Principal Investigator not to conduct research activities on or after the expiration date. The Continuing Review Application must be submitted, reviewed and approved, before the expiration date.

8. Upon completion of the research study, a Closure Report must be submitted to the ORS.

9. Include the IRB study number on all future correspondence relating to this protocol.

If you have any questions contact the ORS by phone at (512) 471-8871 or via e-mail at orsc@uts.cc.utexas.edu.

Sincerely,

James P. Wilson

James Wilson, Ph.D.
Institutional Review Board Chair

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Vita

Todd L. Hutner grew up in Rockville, Maryland with his parents, Janet and Len and sister Julie. After graduating from Rockville high school, Todd attended The Florida State University beginning with the Fall 2000 academic term. While at The Florida State University, Todd earned both a B.S. in Science Education in 2004 and an M.S. in Science Education in 2009.

Prior to enrolling at the University of Texas at Austin, Todd taught high school science in both Florida and Texas. In Tallahassee, Florida, Todd taught Earth/space science at Amos P. Godby high school. In Autsin, Texas, Todd taught chemistry and physics at Lyndon B. Johnson high school. During his doctoral work, Todd also was given the opportunity to serve as a teaching assistant for the UTeach Natural Sciences science and math teacher preparation program.

Upon completion of his doctoral work, Todd will seek employment in an academic, tenure track job.

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This dissertation was typed by Todd Hutner