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EXPLORING THE INTERACTION OF PERSONAL AND CONTEXTUAL FACTORS
DURING THE INDUCTION PERIOD OF SCIENCE TEACHERS AND HOW THIS
INTERACTION SHAPES THEIR ENACTMENT OF SCIENCE REFORM

By

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To Yusuf Kaan

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ABSTRACT

The first years of teaching are demanding as the novice works to gain a degree of familiarity in her/his professional work. It is during this period that many teachers decide to leave the teaching profession or move away from the reform-minded beliefs and practices acquired during their teacher preparation programs. To understand what happens during induction requires a focus on both the cognitive and contextual issues related to science teaching. The goal of this qualitative, multi-case study was to describe the induction experiences of two reform-minded first year science teachers and the strategies they used to negotiate contradictions embedded in the context of schooling. Using the frame of Cultural Historical Activity Theory, in this research I focused on changes in science teachers' personal and professional identities, self-efficacy and pedagogical discontentment, the manner in which these factors shaped science teaching practices, and beliefs and practices shaped and were shaped by the context of the novices' work.

Data included a year of participant observations, surveys, open-ended questionnaires, interviews, classroom observations, and mediating artifacts such as lesson plans and assignments. Identities and dispositions of these teachers played significant role in their attempts to become competent members of their school communities, attempts that influenced and were influenced by their teaching self-efficacy and pedagogical discontentment. Mild contradictions in the system allowed for the refinement of reform-minded science teaching practices, while extreme contradictions in the system served to change one teacher's goals and prevented his successful enactment of science education reform. Findings indicated that the successful enactment of reform-minded practice depends not just on contextual factors related to schools, or just on individual factors associated with science teaching. Instead, personal and contextual factors interact to shape a novice's first year experience. This research also demonstrated that participation

in a professional community that both acknowledges the strengths novices bring into the community and recognizes the support novices need is essential if novices are to become successful members of a community of practice.

One implication of this research is the need to move beyond a singular focus on science teaching and learning in teacher education programs to include an exploration of the affective and professional aspects of teaching. Because this research points to the important role professional development communities play in the development of reform minded science teachers, a second implication of this research is that teacher preparation programs should include a close examination of the role and importance of communities in a teacher's initial success and long term development. Clearly disbanding the professional community constructed throughout a preservice experience upon graduation is artificial and counterproductive. Instead, induction programs that include some members of the preservice science teacher's community may be invaluable for providing support, recognition, and critical lens needed for novices to examine their work as they move into schools as professionals engaged in practice of reform-based science teaching.

CHAPTER 1

INTRODUCTION

The first years of teaching, often referred in the literature as the *induction period* (Gratch, 2001; Liston, Whitcomb & Borko, 2006), have been identified as the most demanding and difficult time in a teacher's career (Imig & Imig, 2006; Luft, 2007). Induction represents a significant transitional period, starting with entry into the teaching profession and ending when the teacher has some degree of familiarity and ease in her/his professional work. Some novice teachers might experience this transition easily while others have difficulties accommodating themselves into the teaching profession. Despite the ease or difficulty, it is clear that this period requires novice teachers to face contradictions in their work. During this period they must attempt to resolve or overcome possible constraints, and in the process of these negotiations, beginning teachers who choose to stay in the profession progressively become full-fledged members of the culture of teaching. Although a novice teacher's experience could be approached through the lens of the preservice preparation or in-service teacher education literatures, Luft (2007) argued that "beginning teachers are different from their preservice and in-service counterparts and deserve some undivided attention" (p. 532).

The literature reveals that the common problems beginning teachers face during their induction period include discipline and class management, contextual contradictions, lack of administrative support, lack of peer support, lack of resources, lack of time because of overloaded schedule, lack of socialization opportunities, and contradictions between theory and practice (e.g. Luft & Patterson, 2002; McGinnis et al., 2000; Simmons et al., 1999; Stockard & Lehman, 2004). Indeed, the list seems endless.

In addition to those problems described above, beginning science teachers also have problems unique to the teaching of science that need to be addressed during their

induction period (Adams & Krockover, 1997). These problems are embedded in the complex nature of the discipline of science, the variety of tasks associated with science activities and laboratories, the extreme amount of preparation required for these activities, and the lack of curriculum guides (Loughran, 1994). Many researchers claim that because of these constraints, novice science teachers often adhere to traditional practices in the classroom rather than employing the reform-based practices that they experienced during their teacher preparation (Luft et al., 2003; Wong et al., 1999). The gist of reform-based practices involves efforts to encourage teachers to employ student-centered instructional practices to actively engage students in activities and conversations that will promote deeper understanding of science (Schneider, Krajcik, & Blumenfeld, 2004). Furthermore, the induction period has become notorious as a time when many beginning teachers leave the profession. The literature indicates a widespread concern about the increasing attrition rate of teachers, particularly in the areas of special education, mathematics education, and science education. The National Center for Teaching and America's Future estimates that 30% of new teachers leave the profession within their first five years (Darling-Hammond, 2000). In the field of science education, one National Science Teacher Association survey reveals that 30% of young science teachers consider leaving the profession in their first years of teaching (NSTA, 2000).

These high rates of teacher attrition, the majority of which occur during teachers' induction years, have prompted a national call for research into the induction period as such research is needed to design effective programs to support beginning teachers (e.g., Century Foundation, 2000; Darling-Hammond, 2000). Although the most obvious goals of such programs include the increased retention of teachers, an important focus of such programs centers around the fate of the science education reforms in the hands of novices who are often considered to be "change agents" for such reforms (Bell, 2001).

Since the early 1990s there has been a strong and persistent reform movement in science education (AAAS, 1989, 1993; NRC, 1996, 2000, 2002). The policies contained in the reform recommendations are rich, and they offer a unified direction to guide the improvement of science teaching and learning. Some of the underlying themes highlighted in the recommendations include an emphasis on scientific literacy for all students, that is, describing the foundational science knowledge all students need to know

to make informed personal and societal decisions (AAAS, 1989). In order to achieve such literacy, the recommendations emphasize an extensive use of inquiry-based instruction, authentic assessment, a curricular emphasis on the interactions of science/technology/society, and embedding such conversations in a robust portrayal of the nature of science. Clearly, the reform recommendations call for a systemic change in the purposes and methods of science teaching and learning.

Responding to the national call for reform, many states developed model curricula and initiated mandatory high stakes testing procedures. Additionally, local school districts adjusted their science courses and teachers were charged with the immense challenge of implementing these diverse and substantial innovations in the science classroom (Haney & Lumpe, 1998). In spite of the explicit reform goals and recommendations, few of the teaching practices suggested in the reforms can be observed in classroom practices (Cuban, 1990; Gess-Newsome, Southerland, Johnston, & Woodbury, 2003; Yager, 1992; Yee & Kirst, 1994). The current picture is one in which many elementary and secondary teachers continue to teach science through traditional textbook-oriented, teacher-centered instruction (Gess-Newsome et al., 2003; Woolfolk & Hoy, 1990).

Yager (1990) reminded us that in order to avoid the consequences of previous science education reform efforts, teachers must be placed at the center of those reforms. Fetters, Czerniak and Shawberry (2002) asserted that teachers are the "change agents"(p.103) of educational reform and that their beliefs cannot be ignored if reforms are to be successful. Echoing this, Haney and Lumpe (1998) and Smith and Southerland (2007) suggested that teachers' beliefs regarding science reform are at the center of educational change.

According to Bandura (2000b), beliefs are the best indicators of the decisions that people make throughout their lives. Bandura (1997) contended that:

Unless people believe they can produce desired effects by their actions, they have little incentive to act. Efficacy-belief, therefore, is a major basis of action. People guide their lives by their beliefs of personal efficacy. Perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to given attainments. (pp. 2-3)

Bandura's (1986) work related to the construct of self-efficacy has been useful in examining science teachers' capability beliefs and their relationship with classroom behavior. For instance, Czerniak (1990) said that science teachers with high self-efficacy are found to be more likely to facilitate reform-based and student-centered teaching methods for their science teaching. Meanwhile those teachers with low self-efficacy are more likely to use traditional teacher-centered teaching methods.

Although the wider literature supports Czerniak's description of a self-efficacy-practice relationship (Woolfolk & Hoy, 1990), other research reveals that some degree of self-doubt in teachers might be useful in advancing school reform and stimulating professional growth (Wheatley, 2002). In his analysis of reform-minded teacher efficacy research literature, [Wheatley identified several veins that teacher efficacy doubts might aid reform by fostering teacher learning]: inducing disequilibrium and change; fostering teacher reflection; supporting motivation to learn and responsiveness to diversity; and promoting productive collaboration.

Another set of constructs that are related to self-efficacy, self-doubt, and teacher retention is found in the quality of the work environment. These contextual factors influence the novice teachers' job satisfaction, which leads them to stay in the profession (Palermo, 2002; Yee, 1990). Yee (1990) stated that there is a strong relationship between beginning teachers' work conditions and their satisfaction, a relationship that holds promise to influence teachers' decision-making regarding their retention in teaching. For example, McGinnis et al. (2004) reported that supportive and respectful school cultures increase the retention of beginning science and mathematics teachers, as such cultures allow the teachers some satisfaction with their new teacher role. This increased satisfaction may be due to the way in which such supportive cultures allow beginning teachers to continue their use of reform-based practices in mathematics and science teaching. Thus, McGinnis et al. suggest that the enactment of reform based teaching practices is linked both to satisfaction with one's work as well as with teacher retention.

In contrast to the traditional belief that teacher' satisfaction and high sense of self-efficacy are essential to reform implementation, researchers working in a related but distinct tradition value teachers' dissatisfaction as a necessary construct for teacher development (Gregoire, 2003). Feldman (2000) stated that teachers' sense of

discontentment in their teaching affects their responses to professional development. Simply said, teachers who are highly confident in their instruction might be highly resistant to change due to their own self-confidence.

In order to “take up” messages of reform, Feldman (2000) claimed that teachers must be dissatisfied with their current teaching practices. He asserts “... that a learner must become dissatisfied with her understanding, a teacher may become discontent with a practical theory because she recognizes it as ineffective, unsuccessful or because it leads to dissonance or dilemmas in practice” (p. 612). Similar to Feldman (2000), Gess-Newsome et al. (2003) pointed to teachers’ dissatisfaction as a promising requirement for teacher change. Gess-Newsome et al. (2003) provided detailed accounts of the nature of teachers’ satisfaction, indicating that the construct has two distinct dimensions: contextual and pedagogical. Contextual dissatisfaction includes teachers’ beliefs about different external aspects of their teaching. Conversely, pedagogical dissatisfaction occurs when a teacher recognizes the mismatch between his/her teaching beliefs, instructional practices, goals and student learning outcomes (Gess-Newsome et al., 2003).

The literature reveals that (1) the teachers are the “change agent” of reforms and (2) the success of reform efforts depend on their practices. These findings, as well as those of Bandura (1997), Gess-Newsome et al. (2003), and Sowell et al. (2006), explain how the degree of efficacy interacts with a sense of pedagogical discontentment to influence how a teacher reacts to messages of reform. “To experience pedagogical discontentment,” a construct they describe as derived from the earlier discussion of pedagogical dissatisfaction, is to experience dissonance with regard to the alignment between one’s teaching goals and actual teaching practices (not the promise of practice, as is measured by self-efficacy). Sowell et al. (2006) posited that the existence of pedagogical discontentment, combined with profound self-efficacy, might enhance teachers’ engagement with professional development experiences toward implementing reform suggestions.

Perhaps the most potentially insightful component of the teacher induction literature is found in revisiting Bullough’s (1989) accounts of beginning teachers’ professional development. In the professional development literature, research suggests that the induction period is the most critical developmental period for a teacher, and that

this period it is highly context dependent and specific to the individual (Bullough, 1992). Additionally, the literature suggests that the most satisfying induction experiences for young teachers occur within a community of practice (Engestrom, 1994) in which beginning teachers have opportunities to participate in a professional community that allows them to discuss new materials, teaching methods, and provides feedback to the novices on their efforts (Bianchini & Cavazos, 2007; McLaughlin & Talbert, 1993).

As one works to bring together these various facets of the literature, it becomes clear that beginning science teachers' sense of self-efficacy beliefs and their sense of pedagogical discontentment are subject to change and these two constructs might have a profound impact on novice teachers' transition to the teaching profession and on their teaching practices during this transition (Gregoire, 2003; Luft et al., 2003; Pajares, 1997; Sowell et al., 2006). Furthermore, contextual influences are also crucial in shaping teachers' induction experiences (McGinnis et al., 2004). In this study, I will seek to understand the pattern of change in reform-minded, novice science teachers' knowledge and beliefs about teaching (paying particular attention to self-efficacy and pedagogical discontentment) as well as change in their teaching practices over their first year in the teaching profession and the most influential factors in these changes.

Statement of the Problem

Most beginning science teachers enter the profession enthusiastically, and they are concerned about providing students with stimulating learning experiences (Cole, 1993). Almost all new teachers believe that all children can learn and many of them are confident about making a difference in their students' lives. However, after their first exposure to the day-in and day-outs of the classroom, these beliefs undergo a sharp change in which teachers modify their beliefs about their students' ability to learn and even their own science teaching philosophies. In these early days in the classroom, novice teachers recognize the ineffectiveness of their current aspects of practices and goals (Cole, 1993; Sowell et al., 2006).

The existing perspective suggests that beginning teachers' senses of self-efficacy and pedagogical discontentment change during the induction period under the influence of contextual factors embedded in the new and unfamiliar teaching and learning

environments. When the novice teachers are in an unsupportive working environment, the change can become very dramatic and might result in teachers' withdrawal from the teaching profession.

Indeed, I argue that it is important to understand how the changes in beginning science teachers' senses of self-efficacy and pedagogical discontentments occur, and how these two constructs interact during early stages of teaching. However, a shortcoming of the discussion to this point is the overly cognitive nature of the conversation. Indeed, much of the literature in this area has an almost sole focus on individual beliefs and cognition and, with the exception of works such as McGinnis et al. (2004), the context in which novice teachers work is often ignored or downplayed. I argue that context is a visceral aspect of the novice teachers' induction period and to best understand what happens during this time requires that we focus both on the cognitive and contextual.

Research Questions

The goal of this study is to gain in-depth understanding of individual beginning teachers' induction experiences and the negotiation strategies they employ in response to the contradictions embedded in the context of schooling. Given that my research foci include both the personal and contextual aspects of teaching, a theoretical perspective that accounts for each seems appropriate. I employed cultural historical activity theory (CHAT) as the major theoretical orientation shaping both the construction of my questions and my research methods (Engestrom, 1999).

CHAT is a theory of human development that perceives societies and their members are mutually constitutive (Wells & Claxton, 2002). Participation in activities is at the center of transformation of novices into competent members of the community; participation in external activity cause individuals to transform internal thought process, and these internal constructions cause the individual to shape the external activity in which they are engaged. Through their internalization of an activity system, new members gradually assemble a general idea of what constitutes the practice of the community and externalization, in turn, takes place as a way in which these new members attempt to develop essential skills to become competent members of that

community through their reflective solutions for contradictions within their activity systems (Engestrom, 1999; Lave & Wenger, 1992; Wells & Claxton, 2002).

CHAT simultaneously allowed me to realize what sorts of changes occur in self-efficacy and pedagogical discontentment of each novice science teacher as well as focus on the factors shaping the changes. Therefore, CHAT provided guidelines to examine what happens to reform-minded individual beginning science teachers during their transition from preservice novices into full-fledged members of the teaching profession.

The overarching goal of this research was to explore the interaction of personal and contextual factors during the induction period of reform-minded science teachers and to document how this interaction shapes their enactment of science reform. I placed particular emphasis on the teachers' negotiation strategies used in response to contradictions embedded the context of schooling. The following were the specific questions guiding this research:

1. How does the activity system for novice teachers change during the course of their first year of teaching?

What self-efficacy beliefs emerge within each beginning science teacher's activity system and how do these self-efficacy beliefs change during the first year of each participant's induction period?

What pedagogical discontentments emerge within each beginning teacher's activity system and how does this discontentment change during each participant's first year of teacher induction?

How do changes in self-efficacies and pedagogical discontentment shape or inform changes in both the teaching goals of these beginning teachers as well as their teaching practices?

2. What factors are most influential in shaping and informing the changes to science teachers' activity systems during the first year of induction?

What are most salient coherences and contradictions of each beginning teacher's activity system for science teaching?

How do these elements influence the belief system, teaching goals, and teaching practices of each beginning teacher as he/she gains experience in the classroom?

As will be discussed, the knowledge resulting from the investigation of these questions offers insight into how best to support science teachers during the induction period. In other words, this research allows the science education community to understand how we can best support these classroom pioneers of systemic change.

Organization of Dissertation Chapters

Chapter Two presents a review of the relevant literature review, focusing on general teacher induction, science teacher induction, science education reform, first-year teachers' professional development, self-efficacy and pedagogical discontentment. Chapter Three explores methodological issues in teacher induction, specifies the theoretical framework of the research and describes the methods employed in this research including data collection, data analysis and rigor of the research. The following two chapters, Chapter Four and Chapter Five, include the findings derived from the first case through employing the theoretical framework of this research, Cultural Historical Activity Theory, introduced in Chapter Three. Specifically, in Chapter Four, after a brief background of first case, I present the findings focused on the changes observed in one novice, Nathan, focusing on his beliefs, self-efficacy beliefs and pedagogical discontentment during the course of first case's first year in teaching. Chapter Five provides a detailed examination of the Nathan's first-year activity system to better understand the factors that shaped the changes described in Chapter 4. Chapter Six and Seven provide the findings derived from case of the second novice, Bob. The organization and content of these chapters echo that of Chapters 4 and 5. Finally, Chapter Eight, includes a cross case analysis, a discussion of the main themes the research, the implications of these themes for different audiences, and suggestions for future research.

CHAPTER 2

LITERATURE REVIEW

The Current State in Teacher Induction

Teacher retention throughout the nation is an ongoing concern among educators and local, state, and federal policymakers (Akerson, Morrison, & McDuffie, 2006). Darling-Hammond (2000) indicates that the demand for teachers is indeed growing, particularly in the areas of special education, mathematics education, and science education. Drawing upon data from the nationally representative Schools and Staffing Survey (SASS) and its supplement, the Teacher Follow-up Survey (TFS), conducted by the National Center for Education Statistics (Ingersoll, 1999, 2001, 2002; Smith & Ingersoll, 2003), Ingersoll and Smith (2003) report that after the first five years of entry, between 40 and 50 percent of all beginning teachers have left the profession. Among these teachers;

- 19% said that they did so as a result of a school staffing action, such as a cutback, layoff, termination, school reorganization, or school closing.
- 42% cited personal reasons, including pregnancy, child rearing, health problems, and family moves.
- 39% said that they left to pursue a better job or another career, and
- 29 percent said that dissatisfaction with teaching as a career or with their specific job was a main reason. (Ingersoll & Smith, 2003, p. 2)

Such a high degree of attrition combined with novices' explanations of the reasons for this attrition further support the need to better understand the period of teacher induction in an effort to better support teachers during this time.

Through this study I aim to document novice reform-minded science teachers' strategies to adapt to particular school cultures. My research object is to understand what self-efficacy beliefs and pedagogical discontentments emerge and how these change within the activity system of first year science teachers during their induction period. By acknowledging the emerging self-efficacy beliefs and pedagogical discontentments, I will be able to assess how these changes in self-efficacy beliefs and pedagogical discontentments shape or inform changes in both the teaching goals of these beginning teachers as well as their teaching practices.

Additionally, by exploring the most influential factors or constraints in these changes, I explore how contextual elements influence the belief system, teaching goals, and teaching practices of each beginning teacher as he/she gains experience in the classroom. The proximal goal of this study is to understand the activity systems of the beginning science teachers during their induction period; however, this lends itself to the more distal goal of designing programs to better aid novices to have more successful and productive induction experiences.

For this research, cultural historical activity theory (CHAT) (Engestrom, 1999) was used as a theoretical framework. This framework enabled me to understand the possible experiences and obstacles that beginning teachers face during their first exposure as professionals in school culture. Other researchers have employed CHAT to reveal that novice teachers become members of the teaching profession through facing contradictions and attempting to resolve or overcome these contradictions (Engestrom, 1994). Additionally, CHAT guided my understanding of the beginning teachers' negotiation strategies for overcoming these contextual constraints. By simultaneously focusing on elements of activity theory including subjects, objects, rules, division of labor, instruments, community, and also outcome, I was able to clarify the interactions between individuals' practices and contextual constraints.

Definition of Induction

A multitude of definitions for induction exist within the teacher education literature. For example, Huling-Austin (1989) suggested that induction is "a transitional period...between preservice preparation and continuing professional development" (p. 3).

Lawson (1991) claimed that “induction begins with the mastery of the profession’s codified culture...and ends when this person is employed and accepted as a full-fledged member of the profession” (p. 20). Gratch (2001) referred to this period as the first year of teaching. Paese (1990) defines induction as “the first three years of teaching” (p. 159). Urzua (1999) suggested that induction is the first stage of a teacher’s career development.

Although there is no consensus definition of teacher induction, it is apparent that teacher induction refers to a transitional period between teachers’ preservice learning and their formal inservice position.

Historical Development of Teacher Induction Research

The historical development of the research on the teacher induction period was mainly limited to the research on induction programs. The first account of research on targeting teacher induction goes back to the 1970s when the Wisconsin Improvement Program initiated their first teacher induction program in 1971. At that time the University of Wisconsin-Whitewater implemented various kinds of induction programs in the areas of elementary, secondary, and special education (Varah et al., 1986). Griffin (1985) specified that the early approaches to induction programs were designed to help beginning teachers fit into the existing school organization through focusing on socialization of novice teachers into the norms of a school, abandoning the preservice mindset and developing teaching competence during this time.

Throughout the late 1970s and early 1980s, Lawson (1992) shows that the emphasis of the research on beginning teachers’ induction focused on management and training procedures; he indicates that these induction policies are influenced by the political waves. Unlike the earlier emphasis, during the 1980s and 1990s political influences and teachers’ growing attrition rate increased the implementation of teacher induction programs. Those programs were designed to assist beginning teachers’ transition from student to satisfied professionals (Bullough, 1992). Gold (1996) summarizes that educational emphasis on beginning teachers focused on retention of beginning teachers, increasing the quality of beginning teachers, and supporting the professional development of novice teachers through induction programs in early 1990s. Kagan (1992) examined studies on both inservice and beginning teachers. She found that

preservice students start their education with beliefs about teaching based upon their experiences with teachers and memories of their own learning experiences. The prior beliefs of preservice teachers about teaching and learning did not change until they were faced with the reality of the classroom (Kagan, 1992). According to Kagan (1992), after starting teaching, novice teachers gained new sets of teaching and learning beliefs that contradicted with their prior beliefs.

For a better understanding of why preservice teachers change their beliefs about teaching and learning, Bullough (1989) argued that school contexts and teacher education programs may have different sets of values. Indeed, sometimes they contradict each other. Therefore, Zeichner and Tabachnick (1981) describe that what beginning teachers' gain during their preservice education may be "washed out" by school experience during their induction period when they are confronted with the daily demands of classroom teaching. Mohr (2000) argued that the "washed out" effect might be associated with reality shock that the beginning teachers' experience during induction period as their previous experiences are challenged or unsupported by teaching environments. Veenman (1984) claimed, "[R]eality shock is the collapse of missionary ideals formed during teacher training by the harsh and rude reality of classroom life" (p. 143). Reality shock occurs when the beginning teachers first start to recognize their own lack of preparation just as they realize the demands of the world of teaching. For example, during the induction period, when novice science teachers' confront the disparity between their student-centered ideology and their survival-based teacher-centered practices, many teachers revert to teacher-centered and didactic form of instruction contrary to student-centered, reform-based approaches that they adopted in their teacher preparation courses. They move toward more traditional approaches to teaching despite their initial views of reform-based practices as being very effective and their intentions to teach in this manner (Brockmeyer, 1998; Lawson, 2005).

Therefore, Sclan (1993) suggested that reality shock might result in diminishing beginning teachers' willingness to put effort into applying their preservice reform-based teaching philosophies in the early months of their career. Even further, reality shock and wash out effect might cause novice teachers to leave the profession. The more problems a novice encounters, the more likely he/she is to leave.

After extensive research on 309 science teachers, Spector (1989) stated that science teachers' development shows a continuum during their lives in the profession. Her findings suggest that beginning science teachers' development and needs are different than that of veteran teachers, and the novices need special support during their induction period--a charge that is further supported by Julie Luft (2007). The common early concerns of beginning teachers include two main dimensions: One of them is contextual problems associated with discipline, management, parents and the community, administration, teaching strategies, colleagues, motivating students, materials, supplies and assessment. The second one is individual problems associated with the feelings of isolation, culture shock, and the confusion of self understanding (Veenman, 1984).

Much of our insight into what happens in the induction period is drawn from studies of induction programs, that is, programs designed to support beginning teachers in meeting their professional needs and reducing the problems that they might face (Wong et al., 1999). Aside from specific information about such programs, the recent general and science teacher induction studies have identified and focused on two main interests. The first interest relates to beginning teachers' beliefs and their influences on novice teachers' induction experiences. The second focus is on contextual influences such as culture of school, physical features, and collegial and administrative support for beginning teachers' during the induction period. In the following discussions I will provide detailed examination of the literature regarding each of these research foci.

Research on Science Teachers' Induction

Gold (1996) indicates that beginning teachers have psychological, logistical, managerial, instructional, and philosophical needs related to their development as professionals. To support that, Anderson and Mitchener (1994) and Roehrig and Luft (2006) suggest that appropriate induction support should be provided with the consideration of all novice science teachers' needs. However, the National Center for Education Statistics (1999b) stated that beginning science teachers are part of a differentiated system in which there is an inadequate availability of supports designed to meet their unique needs. Specifically, the National Center for Education Statistics (1999b) estimates that approximately 50% of all beginning science teachers in the United

States have the opportunity to participate in induction programs. However, among the existing induction programs, none of them addresses the unique instructional aspects of teaching science (Luft & Cox, 2001; Roehrig & Luft, 2006). Thus, Luft et al. (2003) suggest that the beginning science teachers in the United States might not be receiving appropriate support.

Beginning science teachers often face a more diverse curriculum, and they have considerably more content and teaching strategies to select from compared to teachers of other subject areas (Adams & Krockover, 1997; Luft et al., 2003). Consequently, Luft et al. (2003) confirm the necessity of developing research to provide beginning science teachers with effective induction support, support that could play an essential role in the ongoing professional development of science teachers. Dramatically, there has been limited research to guide the development of such support programs for beginning science teachers. Adams and Krockover (1997) agreed, suggesting that future research should underscore the complexities of learning to teach science for beginning science teachers. Indeed, discussions about the professional development of beginning science teachers and the necessity to support novice science teachers through subject-specific, developmentally appropriate induction programs have increased during the last decade (e.g. Adams & Krockover, 1997; Brockmeyer, 1998; Luft et al., 2003; Luft, 2007; Trumbull, 1999).

Throughout the literature, several studies provide significant insights about the induction of beginning science teachers. Drawing upon the studies about general induction programs, it is understood that induction programs for beginning teachers affect their intention and promise to meet novice teachers' needs, ultimately promoting beginning teachers' personal and professional development (e.g. Gold, 1996; Huling-Austin, 1990; Lawson, 2005; Luft & Cox, 2001; Roehrig & Luft, 2006). In support of this assertion, Luft and Patterson (1999 as cited in Luft & Patterson, 2002) stated that 93% of the teachers participating in their induction program showed positive changes in their attitudes toward teaching science, classroom instruction and teaching philosophy. Roehrig and Luft (2006) suggested that novice science teachers need specialized support that addresses their unique pedagogical and content needs including beginning science teachers' frequent concerns such as classroom management and lesson planning and

extends to support in implementing reform-based lessons, planning, managing the laboratory instruction and fostering an understanding of the nature of science among students (e.g. Loughran, 1994; Luft, 2007; Luft & Patterson, 2002). Luft et al. (2003) find that the complex nature of science teaching associated with the discipline of science (i.e., variety of tasks that science teachers have to do, large amount of preparations, and lack of curriculum guides) result in beginning science teachers' movement to traditional teacher-centered practices. Thus, subject-specific support for novice science teachers can be effective. But related literature suggests that content-specific induction programs can be successful in addressing beginning science teachers' unique needs (Roehrig & Luft, 2006).

Teachers Beliefs

The literature on teacher beliefs is extensive and clear in describing that teacher beliefs about teaching and learning viscerally interact with their teaching practices, and this has been very well documented within the science education literature (e.g., Gallagher, 1991; Gess-Newsome et al., 2003; Levitt, 2001; Pajares, 1997; Rowell & Gustafson, 1993; Southerland, Smith, Sowell, & Kittleson, 2007; Tobin et al., 1994).

Research on Beginning Science Teachers' Beliefs

Although the relationship between beliefs and practices is still undefined, the literature on teachers' beliefs reveals that all beginning teachers hold prior beliefs about teaching and learning that might enhance or prevent their professional development in the profession (e.g., Kagan, 1992; Mohr, 2000; Smith, 2005). Many researchers have noted the importance of beginning teachers' prior beliefs during their induction experiences (e.g., Pajares, 1992; Richardson, 1996; Roehrig & Luft, 2006). Additionally, drawing upon their preservice education and past experiences in schooling, beginning teachers hold different types of teaching philosophies, including didactic, transitional, conceptual, and constructivist philosophies (Luft et al., 2003). Researchers with the Salish I Research Project (1997 as cited in Luft et al., 2003) report that didactic and transitional beliefs are indicators of teacher-centered philosophies while conceptual beliefs can be overreaching and provide a quite unrealistic view of students. On the other hand, constructivist and conceptual beliefs align with student-centered teaching practices. It has been an ongoing

concern among educators to define how beginning teachers develop these different teaching philosophies, and to describe how these philosophies influence novice teachers' teaching practices.

Kagan (1992) provided an appropriate account on the origin of beginning teachers' beliefs. She reported that preservice students start their education with beliefs about teaching based upon their experiences with teachers and memories of their own learning experiences. Her examination of beginning teachers also suggested that there is a relatively close relationship between teachers' beliefs, their teaching philosophies, and their classroom actions. Therefore, Kagan described that in order to have a comprehensive understanding of teachers' philosophy of teaching; we must adequately acknowledge the relationships between novice teachers' beliefs and their actions.

Roehrig and Luft (2006) confirmed that beginning teachers' beliefs explicitly influence their teaching practices. In their study on beginning teachers' induction experiences, Roehrig and Luft (2006) find that novice teachers translate their experiential worlds of classroom into a unique view of what represents effective teaching and learning, and they change or solidify their teaching philosophy based upon these beliefs and experiences. Engestrom and Cole (1993 as cited from Engestrom, 1999) argued that most of beginning teachers enter the profession enthusiastically and are concerned about providing students with stimulating learning experiences. Parallel to Cole's statement, a survey conducted by Harris revealed that of 1,002 teacher education graduates, 99% believed that all children could learn, and 83% expressed that they were confident about making a difference in their students' lives. On the other hand, Harris found that after one year of teaching experience, only 48% of these novice teachers believed that all students could learn, and 58% of them thought that before entering the classroom they needed to learn more about teaching and related issues during their preservice education. Consequently, in her early research study, Emmer (1986) stated that the changes in teaching practices and beliefs are expected as beginning science teachers experience difficulties in implementing science lessons.

In order to better understand the change in beginning teachers' beliefs, philosophies and classroom actions, Simmons et al. (1999) conducted a three-year long intensive research study. In this study they sought to understand how beginning science

and mathematics teachers view learning and teaching through focusing on their beliefs and actions. They described the beginning science and mathematics teachers' classroom performance as related to their beliefs and philosophies of teaching and their pedagogical skills on teaching practice. The theoretical framework employed for this extensive study was symbolic interaction. According to Simmons et al. (1999), symbolic interaction differs from other theoretical perspectives because of its approach to socialization. In this framework socialization of the individual self is thought to evolve through individuals' perceptions of their own social experiences. Simmons et al. (1999) explain that language is a tool through which members of a social group exchange, negotiate, and construct individual and shared meaning, thus creating social reality. Based on this framework, the authors seek evidence from the participants' experiences in their own words, their own interpretations of their experiences of a social context, and the interplay of social forces.

Through their data collection and data analysis, they compared first-year, second-year and third-year science and mathematics teachers. In each of these groups they focused on perceptions, beliefs and classroom performances as related to their beliefs and teaching philosophies as well as their pedagogical content skills.

Simmons et al. (1999) argue that when teachers participate in the social environment of a classroom, they construct specific skills to function. These skills then influence their beliefs and practices in their classroom. For example, the authors affirm that many first-year teachers describe themselves as very student-centered. On the other hand, depending on classroom observations, beginning science and mathematics teachers' practices reveal practices that are rather teacher-centered in nature. Simmons et al. (1999) describe that most beginning teachers "wobble" between teacher-centered, conceptual, and student-centered teaching styles. In contrast, as they continue in teaching, teachers' beliefs about their understanding of subject matter, their actions, their students' actions and their teaching philosophies, novice teachers' beliefs and practices become more congruent to a teacher-centered approach. The authors suggest that novice teachers construct their teaching philosophies into a category of beliefs consistent, coherent and adequate to validate their actions in their classroom. However, it is important to note that such philosophies are not always coherent.

Simmons et al. (1999) go on to state that it is through personal actions and social interactions in social environments that beginning teachers organize and construct their beliefs, teaching philosophies and classroom practices. Logically, change in each beginning teachers' actions and beliefs occur in a specific social context. Therefore, their research reveals that change in beginning science teachers' actions toward reform-based teaching is very complex, individual and context dependent.

Structural and Cultural Contexts of Teacher Induction

It is widely recognized that the school context in which teachers and students operate influences the decisions that teachers make during teaching and learning activities (Andersen et al., 2004; McGinnis et al., 2004; Smith, 2002, 2005; Yore et al., 2007). Coble and Koballa (1996) call for researchers to focus on the impact of culture of extant practice on beginning science teachers during their induction period. One of the recent responses to this call is McGinnis et al.'s (2004) study on the cultural perspective of the induction of reform-minded beginning science and mathematics teachers. To better understand challenges that novice science and mathematics teachers' face during their induction period, McGinnis et al. (2004) use a cultural perspective in their recent study.

Similar to other recent studies of induction (e.g. Simmons et al., 1999), McGinnis et al. (2004) apply the symbolic interactionist theoretical framework, which places emphasis on social construction of meaning in a culture by examining the process of how individuals define and interpret each other's actions within the specific culture (Miller, 2006). The participants of this study were five first-year and two second-year middle school and elementary level mathematics and science teachers. All of them were graduates of the Maryland Collaborative for Teacher Preparation [MCTP], a statewide reform-based undergraduate teacher preparation program supported by National Science Foundation funding. By carefully examining participants' interpretations of each other's actions, McGinnis et al. (2004) provide an insight about how individual beginning teachers either sustain or transform the way they view the existing culture in the schools.

Specifically, McGinnis et al. (2004) argue that through examining the school culture in which teachers and students interact with one another, we might develop a more inclusive understanding of how culture and its diverse manifestations appear to

impact the beginning science teachers' professional development and their career decisions. Consequently, the authors report that an understanding of beginning science teachers' cultural experiences and concerns within a school environment can be used to support beginning teachers' reform-based science teaching practices and also improve teacher retention.

In their research, McGinnis et al. (2004) agree that the beginning science and mathematics teachers participating in their study entered the workplace with the capabilities, intentions and philosophies to enact reform-based teaching practices. They find that although these novice teachers were reform-minded, the primary limiting factor affecting the long-term success of the beginning teachers in implementing reform-based teaching practices is their perceptions of school culture. In the study, culture is the interconnected relationships among principals, teachers, students, staff, district curricula, and assessment demands. Within such interconnectedness, school contexts that supported and respected the reform-minded beginning teachers resulted in satisfied, stable and effective beginning teachers. On the other hand, the results also revealed that beginning teachers face frustrations and dilemmas between their preservice experiences and the workplace experiences if their school cultures lack consideration and support for beginning teachers' enactment of reform-based practices.

McGinnis et al. (2004) also reports that the school context in which the new teachers begin their teaching is a major factor in determining the regular implementation of reform-minded science and mathematics teaching. The affordances and constraints that novice teachers encounter during their teaching influence these beginning teachers' curricular, instructional and assessment practices. For example, if the beginning teachers perceive a mismatch between how they intend to teach and the school administration's demands, specifically the district's curricula and assessment criteria, teachers' enactment of reform-based practices are unsuccessful.

The ultimate conclusion of McGinnis et al.'s (2004) study is that the supportive and respectful school contexts (1) extend the quality of beginning teachers' reform-based practices in mathematics and science teaching and (2) hold promise to increase the retention of beginning science and mathematics teachers within those school cultures.

Likewise, Palermo (2002) posited that the quality of the work environment influences the novice teachers' job satisfaction which, in turn, leads them to stay in the profession. Similarly, in science education, Costa (1997) examines the complexity of high school level science teaching through cultural perspective. Costa describes that the culture of science, the culture of the students and the teachers and the culture of the school impact beginning science teachers' professional lives.

More specifically, Yee (1990) provides empirical evidences for the strong relationship between beginning teachers' work conditions and their satisfaction, which holds the key to their decision-making on remaining in teaching. For a better understanding of the relationship between context and beginning teachers' decision making, Yee (1990) provides a profound account on how workplace conditions influence beginning teachers' career outcomes. Besides beginning teachers, Yee (1990) also included veteran teachers and their experiences into her study. By applying qualitative and quantitative research procedures, including in-depth interviews, surveys, conversations, document inspection, and observations, the study revealed that all veteran teachers who participated in her study also confronted the difficulties typically associated with work conditions during their first years of teaching.

Yee (1990) identifies influencing work conditions as: (1) building-level context factors including student discipline, (2) course assignment, (3) level of support during induction, (4) class size, (5) workload, (6) professional encouragement, (7) collegial interaction, (8) opportunities for input, and eventually (9) organizational choices such as administrative policies and practices, instructional supplies.

One of the most important conclusions of her study is that each school has its own culture and work conditions, which influence beginning teachers' satisfaction in various ways. Indeed, a prominent result of this study was that each beginning teacher's experiences and problems are unique and depend on the work conditions of the school environment. Consequently, Yee (1990) reports that teachers in different schools struggle with unique complex issues of school context.

Satisfaction of Beginning Teachers

Novice teachers' satisfaction may be one of the primary influences on the rate of teacher attrition. Ingersoll (1999) reports that teachers' work satisfaction is an important aspect influencing beginning teachers' decision to leave teaching. He suggested that beginning teachers' lack of satisfaction relates to contextual aspects including overloaded teaching assignments, lack of collegial and administrative support, the demanding administrative practices and policies within schools, lack of student motivation, and powerlessness with regard to decision-making.

For a better understanding of the context-satisfaction relationship, Stockard and Lehman's (2004) illustrates that in the complex culture of teaching, teachers' satisfaction depends on (1) the support beginning teachers receive from others; (2) the control they have over their work environment; (3) the mentoring they receive, (4) the extent to which they are successful in the classroom; and (5) the extent to which their teaching environments are safe and orderly.

Stockard and Lehman (2004) describe that teachers with fewer resources and lack of administrative and collegial support are likely to express dissatisfaction or leave teaching at the early stage of their profession. They argue that teachers who believe they are using complex or higher level skills or who believe that they have high levels of organizational and student management skills are more satisfied with and committed to their work. Ford (1992) relates this to self-efficacy beliefs as part of personal capabilities that motivate teachers to perform competently. He argued that the development of personal capabilities is dependent on responsive environments.

Furthermore, Yee (1990) examines the relationship between teaching context and beginning teachers' self-efficacy beliefs. In her study, she found that beginning teachers' self-efficacy and overall commitment to teaching are linked to job satisfaction. Yee (1990) indicated that the social organizational structure of today's schools create conditions in which the school context might hinder beginning teachers' motivation to commit to their career choice of teaching and to stay in teaching. For a better understanding of context-retention relationship, Kyriacou (2001) investigates why some teachers are able to successfully negotiate periods of career reappraisal and retain a positive commitment to the work, while others are not. Kyriacou (2001) contends that

excessive demands on beginning teachers and beginning teachers' concern with their self-image results in stress for those teachers. As an implication of his exclusive literature review, he suggested that to reduce teacher stress, organizational arrangement and supportive leadership through appropriate supervision and positive communication are needed. With such contextual support, teachers may have reduced professional stress, enhanced motivation and thus be less prone to leave the profession.

Looking more specifically at teachers' stress as related to workplace rewards, Strong (2004) explores how the negative effects of extrinsic motivation and low intuitive rewards for beginning teachers can increase stress and lead to attrition. By viewing the relationship between work conditions and beginning teachers' satisfaction, Darling-Hammond and Sclan (1996) suggest that in order for teachers to remain in the teaching profession, the rewards must compensate the frustrations. Consequently, in terms of the relationship between external factors and intrinsic motivation, beginning teachers' performance efficiency is strongly affected by the intuitive rewards (not extrinsic rewards) and positive feedback and recognition from principals and colleagues (Olitsky, 2006; Strong, 2004; Yusko & Feiman-Nemser, 2008).

Besides the organizational support system, Trumbull (1999) reports that novice teachers initially struggle to adjust and enact their planned instruction and curriculum, and their concerns are primarily about their grasp of the material, their design of the lesson and the outcome of their teaching. Trumbull's statement indicates that beginning teachers need more time to spend for their planning and other school related matters than do experienced teachers. By making sure that beginning teachers are given appropriate time during the day to plan, work with other teachers, and observe other's teaching, their stress might be lessened, and many other potentially serious problems such as feelings of isolation and burn-out might be prevented (McCarthy, 2006).

In a recent study, Palermo (2002) illustrates and further examines beginning teachers' work conditions and how these conditions affect their future career choice. She stated that:

School context is an area that demands understanding and consideration when retention is the issue under examination. Although school context in and of itself does not drive a new teacher's decision to stay in teaching, it has been shown to

influence the effectiveness, success, and job satisfaction of the new teacher. Principals can manipulate school context and create the climate within which teachers teach and students learn. The relationship they establish with a new teacher may be a major determinant in the positive or negative imprinting of a teacher's first year. (p.33)

Clearly, beginning teachers' future success and retention in the profession depend on the support systems provided by the administration of their schools and districts.

Collaboration in Teacher Induction

Related to the discussions on contextual influences on beginning teachers' development, another conclusion drawn from the teacher induction literature is that during the induction period beginning teachers need extensive support for their transition from preservice education to the teaching profession. With respect to transitional help for beginning science teachers, collaboration is often very useful provider of such support, and includes collaboration between universities and school districts (Luft et al., 2003; Scott, 2006) as well as collaboration between teacher education institutions and school districts (Watson, 2006).

The Holmes Group (1986 as cited in Luft et al., 2003) reports that creating collaborative environments between districts and schools leads to more effective induction programs to support beginning teachers. Therefore, in terms of cultural constraints embedded in school environments, Wong et al. (1999) suggested that districts and schools administrations need to acquaint beginning teachers with the unique needs and cultural characteristics of the students whom they taught. To support beginning teachers, workshops and other in-service activities must be developed with the consideration of specific school environments where the novice teachers work (Wong et al., 1999).

In another study, McGinnis et al. (2004) argued that in terms of evaluating beginning science teachers' reform-based teaching practices, school principals traditionally evaluate the beginning teachers by using school district guidelines that might not support reform-based practices. Evaluating beginning science teachers who are

enacting reform-based practices by criteria that do not match reform-based enactments might result in the beginning teachers being negatively evaluated (McGinnis et al., 2004).

Because of the unique nature of beginning science teachers' induction period (Sadler, 2006), collaboration between teacher education institutions and school districts can be critical in implementing induction programs (e.g. Brockmeyer, 1998; Luft et al., 2003). With regard to the division of labor in science teachers' induction programs, school districts might need to meet psychological, logistical, and managerial needs of beginning teachers, whereas teacher education institutions would support these novices by meeting their instructional and philosophical needs (Roehrig & Luft, 2006). Besides, Engestrom (1994) argued that preservice method courses often suffer from the contextual contradictions associated with tools such as textbooks and lecture contents, which tend to become objects in themselves, disconnected from the classroom practices. Therefore, in terms of collaborative support for beginning teachers during their induction period, McGinnis et al. (2004) suggested that during their preservice education and internship period, the teacher education programs should be designed to inform novices about the concept of school context and its role in their development and practices.

Beginning Teachers' Professional Development

Teacher Development

The construct of teacher development is dependent on concrete classroom applications of general ideas, and it involves opportunities for actual practice rather than mere descriptions of practice; while observation, critique, reflection, group support and collaboration, evaluation and feedback by skilled practitioners do help if the practitioners have a wealth of experience teaching, teacher development does depend on opportunities for actual classroom practice (Elmore & Burney, 1997; Sadler, 2006). Throughout the literature, teachers' development has been understood as a key concept for ensuring the implementation of educational reform (Southerland et al., 2007; Yager, 1992). However, the current reform efforts are criticized by unrealistic expectations from teachers who do have a wealth of classroom practice and find it difficult changing their practices. For example, McIntyre and Hagger (1992) stated:

Development takes what is there as a valuable starting point, not as something to be replaced, but a useful platform on which to build. To do so is to recognize not only that teachers do have valuable existing expertise but also that, if teachers are forced to choose, they will usually revert to their secure established ways of doing things. The metaphor of ‘building on what is already there’ is not, however, satisfactory because it suggests adding on something separate to what is there; something extra on top. The concept of development, in contrast, implies that whatever is added, whatever is new, will be integrated with what is there already, and will indeed grow from what is there. (p. 271)

As McIntyre and Hagger (1992) indicate, the persistent failure of existing reform efforts is caused in part because the impetus for change often comes “from outside” the teachers. These reforms do not meet the needs and concerns of teachers; reformers often do not think of the introduction of reforms in developmental terms.

In the science education literature that focuses on the support of beginning teachers’ development, there are eight broad problem areas to be addressed. These include discipline, motivating students, dealing with individual differences, assessing students' work, relationships with parents, organization of class work, insufficient or inadequate teaching materials, and dealing with problems of individual students (Sadler, 2006; Roehrig & Luft, 2006). Wanting to go beyond listing of problems surrounding teacher development, Veenman (1984) suggested three frameworks that might be used to examine such teacher difficulties: a developmental stages framework; a cognitive development framework; and a teacher socialization framework. These frameworks of teacher development attempt to explain individual changes. When they are viewed as a complementary framework, together they provide a more complete picture of the needs of beginning teachers. This combined framework may lead to possible understandings of how to support beginning teachers in their induction years.

In the following section, I present these teacher development frameworks through the exploration of the relevant literature.

Science Teachers' Developmental Stages

Drawing upon a seven-year study of 309 science teachers, Spector (1989) explains that during their teaching careers, science teachers go through five development stages; induction, adjustment, maturation, mid-career crisis, and leadership. Through interviews and observations, she identifies these stages by examining the science teachers' behaviors, self-confidences, decision-making abilities, choices of instructional methods, and their relationships with students, teachers, administrators, parents, and university faculty.

The induction stage: In this stage, teachers focus on their survival within the school environment. At this point they are textbook bound, avoiding laboratory activities because of their fear of losing control of students. During this stage, the novice science teachers often recognize conflicts between their preservice learning and the realities of actual classroom.

The adjustment stage: Spector (1989) contends that during the adjustment stage the teachers focus on presenting subject matter. They enthusiastically respond to students' needs, and they try to apply what they learned to their teaching. Although they start collaborating with other teachers, they are very worried by beliefs about teaching that are different from their own.

Maturation Stage: Spector (1989) describes teachers in the maturation stage as self-actualizing, confident, secure and at ease. In this stage, they focus on students' various needs. Teachers in maturation stage can present a concept in many innovative ways to address individual student needs.

Mid-Career Crisis: During this stage, their development shows a reverse direction. They again focus on themselves and their survival. Similar to teachers in induction stage, teachers in mid-career stage also have difficulty in making decisions. According to Spector (1989), during this stage, teachers experience discomfort about teaching. Consequently, in their mid-career crisis, teachers often consider changing their career either seeking to have another position in education or leaving teaching.

Leadership Stage: In this stage, teachers see themselves as effective professionals with high confidence in teaching. Spector (1989) affirms that teachers in leadership stage

share their expertise with others and they collaborate with teachers within their schools and other schools, districts, and states, and are active in professional associations.

By identifying these five developmental stages that teachers go through, Spector (1989) provides a conceptual foundation for a better understanding of the professional development of teachers, especially those of beginning teachers. On the other hand, this study lacks insight into how teachers achieve the multifaceted transitions between these stages. Therefore, it is necessary to understand underlying cognitive development features of beginning teachers, and this can be accomplished through reviewing the relevant literature.

Cognitive Development of Beginning Teachers

Becoming a teacher is inevitably an idiosyncratic process (Bullough, Knowles, & Crow, 1992 as cited in Bullough, 1992). Past experience, personal characteristics, and context each dramatically influences the beginning teachers' decision making as they negotiate a teaching role and adjust to teaching as a profession (Eick & Reed, 2002; Smith, 2005). Bullough (1992) strongly recommends that both preservice and in-service teachers pay close attention to the personal dimensions of becoming a teacher. By strengthening personal teaching philosophies and practicing them in teaching tasks such as curriculum design, beginning teachers avoid loss of self. Additionally he stresses that the relationship between context and teachers' development should be underscored. Bullough (1992) indicates that the conception of beginning teachers' professional development is associated with involvement and community building rather than challenging the hierarchical and bureaucratic organization of schooling. He goes on to assert that one without the other would represent an asymmetrical education and an extremely naïve view of human development and the power of institutions to influence that development.

Following this notion of power, McGinnis and Parker (2001) explain that beginning science teachers' social strategies in response to specific instances of perceived power in a school context are *resistance, moving on, and exit*. Likewise, McGinnis et al. (2004) illustrate the use of power and its influence on beginning teachers' development. According to the authors, evaluating beginning science teachers who are enacting reform-

based practices by using evaluation criteria that do not match reform-based enactments might result in these teachers being reluctant to try new teaching methods.

Indeed, in his early studies, Bullough (1992, 1989) shows that beginning teachers' professional development holds promise for them to develop necessary skills to overcome perceived constraints and problems during their induction period. Bullough (1989) points out that beginning teachers' efforts to negotiate satisfying teacher role is important for them to stay in the profession. The construct of satisfying teacher role means one's attainment of his/her desired teaching goals (Bullough, 1992). According to Bullough (1992), developing into a genuine teaching professional and having satisfying teacher role reflect more than a symbolic occurrence; it requires working on some aspects simultaneously. Drawing upon his studies on beginning teachers, engaging in curriculum development, developing a sense of knowledge of self, being socialized within a community of practice are crucial aspects for beginning teachers' development. To broaden the understanding of beginning teachers' development, I explore these aspects in the following section in light of the relevant literature.

Curriculum

Bullough (1992) understands curriculum development as a way to support beginning teachers' professional development, not only to enable student learning, but also their own development. He sees curriculum development as a vehicle for novice teachers constructing a satisfying teacher role. Beginning teachers' lack of knowledge about teaching and curriculum development increases their dependence on other teachers' expertise on curriculum development (Bullough, 1989). This dependence results in beginning teachers' insecurity and difficulty to structure their desirable teaching philosophies.

Indeed, the portrayed role of teacher as implementer of a determined body of knowledge is often a source of difficulty for beginning teachers (Bullough, 1992). According to Bullough (1992), the demand on beginning teachers is not only to implement a curriculum usually developed by others and with which they are unfamiliar; they also must negotiate a satisfying teaching role at the same time. Bullough (1992) explains that these two demands are usually contradictory to each other. Contradiction

happens when the adopted curriculum prohibits beginning teachers from establishing a satisfying role and the desired role makes it difficult for them to implement the established curriculum. Specifically, beginning teachers need to understand the relationship between curriculum decision-making and their own movement toward a satisfying teacher role (Bullough, 1992).

Knowledge of Self

Another construct related to teachers' development of satisfying teaching roles is the notion of knowledge of self. Bullough (1989) suggested that sufficient knowledge about beginning teacher development helps beginning teachers to confront their struggles and problems as normal occurrences and as central to avoiding institutional submersion and loss of self (Bullough, 1992). He goes on to claim that lacking experience and being uncertain about oneself forces beginning teachers to rely on an existing school context and set aside their willingness to attain their teaching goals. Within the framework of teachers' developmental stages as discussed earlier, knowing that their struggles and problems are normal and that there are different ways of approaching these problems may lead these novice teachers to attain their teaching goals. This empowering strategy may lead beginning teachers to the establishment of satisfying teaching roles.

According to Bullough (1989), beginning teachers' development of a wide range of skills to negotiate the constraints embedded in teaching environments are essential to maintaining a positive teaching presence for beginning teachers. These required skills are associated with maintaining and enhancing one's sense of self as worthwhile and a contributing member of a profession. In short, success in developing these skills is associated with staying alive professionally, thus allowing teachers to avoid burnout.

Gratch (2001) examines how internal and external forces impact the self-conception of beginning teachers and the teaching choices that they make. Gratch (2001) uses critical theory to argue that transformation is a challenge to the status quo; such transformations allow space for teacher agency in the socialization process. In this one year, multi-case study, the participants were 38 teachers at three different phases of their teaching. Twelve of them were preservice teachers with majors in education; 16 were teaching interns during their final semester of undergraduate studies; and 10 of them were

first-year teachers. Gratch reports that the success of beginning teachers in meeting the needs of their students is influenced by the success of these beginners in negotiating complex cultures of the teaching environment as well as their ability to reflect on internal beliefs and expectations for oneself as a teacher.

Theory of Reflection in Teacher Induction

The common concern among teacher educators is how beginning teachers can be assisted in translating their theoretical pedagogical knowledge into applied pedagogy (Sadler, 2006). In terms of beginning teachers' use of their preservice knowledge to inform their practice, Van Manen (1995) reports the tension between what they learned about teaching and what they discover is required in the practice of teaching. He argued that this tension is one of the most persistent problems of beginning teachers. Van Manen describes that before entering the interactive reality of teaching, a well-prepared beginning teacher needs to gain excellent subject matter expertise, theories of child development, models of teaching and classroom management, practical and reflective skills with successful peer-teaching exercises and classroom observations, and critical understanding of philosophical, political, and professional educational issues. Even if the new teacher has a successful preservice experience, Van Manen (1995) stated that beginning teachers typically encounter great frustrations as they first enter the classroom. The new teachers are inevitably disappointed when all their planning still falls short of what is required by classroom realities. They often find that their knowledge base of the subject matter, teaching skills, educational theories, and curriculum programs do not match the demands of the pedagogical life in the classroom.

In reaction to the assertion that a technical theory-into-practice epistemology is not responsive to the understanding that teacher knowledge must play in responding to the challenges of the school and classroom, van Manen (1995) suggested that teachers should be reflective practitioners. The notion of reflective practitioner originated in Schon's (1983) work in the practical domain of teacher development (Feldman, 1997).

The theory of reflection suggests that novice science teachers need to reflect upon their practices in order to develop (Luft & Patterson, 2002; Roehrig & Luft, 2006). In his early study on teacher development, Kagan (1992) reports that beginning science teachers

need opportunities to explore and examine their instructional and curricular decisions. Consequently, by exploring and examining their own decisions, they might be able to modify their beliefs and practices (Roehrig & Luft, 2006).

For further understanding of the importance of reflection, Richardson (1996) explains that teachers' reflection on their practice directly impacts their beliefs and practices, and enhances their ability to use more constructivist approaches. Additionally, van Manen (1995) describes reflection as a potential way to support and improve teachers teaching practices in three ways. First, through reflecting their practices, teachers are able to examine, frame and solve dilemmas embedded in the classroom. Second, reflection increases teachers' awareness of the knowledge and assumptions they bring to teaching. Finally, it also enables teachers to take an active role in their professional development. Consequently, Luft and Patterson (2002) indicate that purposeful and focused reflection is crucial to help beginning teachers to develop their own theories of practice, and strengthen their teaching philosophy, which ultimately guide their practices. Thus, we see that practice and supported reflection on that practice are essential to teacher development. However, Van Manen (1995) argued that although beginning teachers might be informed about the notion that good teachers are reflective teachers, they often face difficulty in determining where and how the reflective process should enter the life of teaching.

Besides the construct of reflective practitioner, literature on beginning teachers also reveals beginning teachers' involvement in community of practice as another profound vein to support beginning teachers' development (Eick & Dias, 2005).

Teachers' Learning through Socialization

Bullough (1992) argued that the contextual factor of the community plays a significant role in inhibiting or enabling beginning teachers' ability to negotiate a satisfying teaching role. In his research, Bullough (1989) explains that community members within a school context influence teacher beliefs and enable or constrain efforts to negotiate a satisfying teacher role. More broadly, his work suggests that there is a dialectical and mutually constitutive relationship between the person and community.

The National Research Council (1996) also reported that students' learning might be supported by situating it in meaningful contexts, and creating learning communities in which teachers and students engage in rich discourse about important ideas. This suggestion highlights the importance of situated cognition and communities of practice. Drawing upon these ideas, Smith (2005) suggested that the physical and social contexts in which teaching and learning take place are an integral part of teaching and learning activities. The situational perspective on learning focuses on interactive systems that include individuals, as participants, interacting with each other as well as physical and social contexts (Cobb & Bowers, 1999; Lave & Wenger, 1991).

Perhaps the most profound assertion from this perspective is that the process of learning is a social occurrence (Lave & Wenger, 1991). Indeed, some researchers define learning as knowing how to participate in the discourse and practices of a particular community (Cobb & Bowers, 1999; Collins, 2004; Lave & Wenger, 1991). Thus, through social constructivist lens, echoing Driver et al. (1994) assertions, Friedrichsen, Munford and Orgill (2006) describe learning as an individual's process of enculturation through which the person comes to understand a community's ways of thinking and practicing. Therefore, Lave and Wenger (1991) suggest that instead of considering cognition solely as a property of individuals, cognition is distributed among the individuals as well as interrelated with the contextual features of a specific environment.

Additionally, Gratch (2001) indicates that by developing the skills and attitudes needed to take advantage of socialization opportunities, beginning teachers are more likely to continue to develop professionally and to remain in teaching. By focusing on beginning teachers' experiences, she describes that beginning teachers need to understand their rights and responsibilities and have communication skills necessary to negotiate the contradictions and problems embedded in complex contexts of teaching in order to continue to develop beyond their survival level. It seems productive to position beginning teachers' socialization as occurring in a community of practice.

Given that learning is socially constructed in the discourse communities in which teachers work and learn, research results suggest that for teachers to be successful in constructing new roles, they need opportunities to participate in a professional community that discusses new materials and teaching methods (Friedrichsen et al., 2006;

McLaughlin & Talbert, 1993). As parallel to this view, Putnam and Borko (2000) define this process as *beginning teachers' enculturation*. In terms of beginning teachers, Putnam and Borko (2000) argue that novice teachers should be incorporated into a community of practice so that they can support their professional and pedagogical development through conversations--echoing the need for supported reflection discussed earlier. Engestrom (1994) defines community of practice as:

Skills and knowledge are manifested and evolved in relatively stable communities of practice, typically workplaces. Teaching individuals separated from their communities of practice is often ineffective and leads to little improvement in the work practice. Investigative learning requires a learning community. (p. 123)

However it is important to point out that the discussions of many teachers in their workplaces do not always provide rich conversations for meaningful reflections (Ball, 1994). Indeed, in many school environments, the existing structures of communities do not support critical and reflective examination of teaching practices. Thus, McLaughlin and Talbert (1993) state that the notion of beginning teachers' enculturation into schools often hinders or even prevents the beginning teachers' development if existing communities are not supportive of reflective actions, something that is required to transform practices. Therefore, for successful implementation of reform recommendations in education, community support for beginning science teachers seems to be one of the necessary ways to assist fresh-minded change agents (Price & Valli, 2005), many of whom are beginning teachers during their induction period.

Teachers' Learning in Community of Practice

By taking part in joint activities novices are inducted into the community; through participation, new members first internalize and externalize these activities (Wells & Claxton, 2002). Through their internalization, new members gradually construct an understanding of what constitutes the practice of the community. Externalization, in turn, takes place as a way in which these new members attempt to develop essential skills to become competent members of that community through their reflective solutions to contradictions within their activity systems (Engestrom, 1999; Lave & Wenger, 1991; Wells & Claxton, 2002). Drawn from the trajectories of both CHAT and the situated

perspective, for novices the incentive for acquiring new information and skills does not solely emerge from intrinsic interest in the activity, but also from the desire to contribute as valued members of a community. Within this framework for understanding the work of novice teachers, it is particularly important for beginning science teachers to experience a positive sense of interaction within social settings as they work to become members of a community of practice (Olitsky, 2005).

Interaction rituals are one means to generate a positive sense of interaction and energy in a work place. Collins (2004) described interaction rituals as a build-up of mutual focus, the development of a common rhythm and mood, and, consequently, an increase in positive feelings associated with the group. Such rituals contribute to emotional energy becoming associated with the group and its symbols. Much of the positive feelings generated around community interaction rituals come from the reciprocal contribution of community members to the novice's development of skills and novice's contribution to the transformation of the object of entire activity system (Collins, 2004). For Collins a newcomer's sense of contribution to an activity system helps him or her to feel sense of belonging to the activity system, which eventually enhances the novices' willingness and helps them to maintain their willingness to participate in the activity system (Collins, 2004). Thus, interaction rituals and the positive energy they allow do much to mechanize the transformation of novices into members of the community.

In the next section, I explore the literature on science education reform as a discussion of the importance of beginning science teachers in reform efforts.

Science Education Reform and Teacher Induction

The past decade has witnessed calls for reform in science education from major organizations such as AAAS (1993) and NRC (1996). Gess-Newsome et al. (2003) report that by the influx of an immense amount of time, money, and effort, reform attempts have focused on three main aspects: (1) teacher professional development, (2) cultural and structural context of instruction, and (3) teachers' thinking. In spite of the substantial work and investment, reform efforts in science education have not resulted in sustained

fundamental changes in classroom practice (Berliner, 2006; Gess-Newsome et al., 2003; Southerland et al., 2007).

In his two-year qualitative case study, Brooks (2006) explores how teachers navigate the professional and personal world shaped by the current educational reform efforts. Through the lens of sociological conceptual framework, Brooks (2006) identifies that disengagement, sporadic teacher recognition, intrusion from policymakers, and organizational or managerial deficiencies are some of the main problems for the failure of education reform efforts. Similarly, Yee and Kirst (1994) provide an extensive examination of unsuccessful reform efforts. They point out three major factors limiting reform implementation: (1) Lack of consideration given to how the reform-based instructional practices of each reform project would be taught to practicing teachers; (2) teachers' experiences, pedagogical and content knowledge were not appropriate to implement new reform materials; and (3) the reform practices were developed without accounting for the unique structural constraints to changing teacher practice.

In the reform literature, teachers are recognized as central to current reform efforts. Yager (1992) indicates that the success of reform-based instructional implementations depend on teachers' understanding of reform implications, their pedagogical knowledge and content knowledge background. Therefore he stated a set of suggestions for teachers if they are interested in implementing reform-based practice.

1. Internalize goals for science teaching other than a preparatory one; that is, preparing for further study of traditional science concepts. There is a common belief that action as a result of instruction must first come after mastery of basic concepts.
2. Be willing to abandon standard textbooks where there is less than 10% variation from one text to the next at a given grade level. Currently only 10% of the teachers are willing to abandon their basic textbooks.
3. Assist students in utilizing science concepts and processes in attacking problems that exist in their own lives and communities. Currently less than 10% of school graduates are able to use and to act upon the information and skills they are taught.

4. Assess student success with teaching and learning beyond testing students for the degree they can repeat information or perform certain basic skills outside any real-world context.
5. Be involved professionally and demand new approaches and materials (a critical mass of 25% of teachers is needed to affect the preparation and use of improved materials, and currently only 15% are so involved) (p. 908).

With respect to the current reform literature, Supovitz and Turner (2000) agree that the major component of current reform efforts is professional development, which is thought to enhance teachers' personal commitment to teaching through opportunities to learn for their students. Professional development activities are seen as an important support services that help beginning teachers to maintain their reform-based philosophies and practices during the induction period. Roehrig and Luft (2006) explain that through professional development activities, beginning teachers should be supported to learn, rethink and adopt different knowledge, thoughts, and practices related to teaching while moving these novices toward reform-based teaching practices. Wong et al. (1999) suggest that these professional development activities should be interactive in nature if they are to be effective means of novice teacher support. They go on to suggest that besides the interactive professional development events, resource assistance such as leadership, materials, money, is essential, along with direct emotional support if schools and district administrators are to support to beginning teachers during their induction period.

Indeed, school administrators can be an important piece of the puzzle of induction support. Watson (2006) highlights the importance of administrators' strong leadership role, explaining that if beginning teachers are to be successful, their supervisors including mentors and administrators must be committed to not only providing them resources, but also being a resource for them. Hughes (1999) indicates that administrators can also facilitate the adaptation of beginning teachers to the school by informing them about basic resources, services, procedures, and policies of the school. Therefore, school and district administrators should underscore that while workshop, inservice activities and orientations are one part of beginning teachers' professional development, beginning

teachers might need to engage in other kinds of activities which straightforwardly address their instructional and classroom management aspects of teaching (Watson, 2006).

It is important to note that inservice activities offered for beginning teachers during their induction period can be a help or a burden. Their usefulness depends on when such activities are offered and how applicable the content is perceived to be by the novice teachers. Based on their research, Wong et al. (1999) identify some ways in which schools and districts can ensure the effectiveness of inservice activities in meeting the needs of beginning teachers. One of them is to survey beginning teachers before these activities are determined to see where their interests and needs are. Another suggested strategy is to have separate inservice for beginning teachers, allowing for a focus on their unique needs. Additionally, they suggest giving novice teachers the choice to attend a specific inservice activity or generate inservice programs with a choice of topics built into them.

Wong et al. (1999) indicate that inservice activities might play a significant role in bridging the gap between beginning teachers' theoretical knowledge and the applicability of that knowledge, as long as the activities are applicable to beginning teachers' instructional practice. Consequently, Wong claimed that when novice teachers feel the inservice does not contribute to their overall knowledge or repertoire of professional skills, they hold little patience for attending it. Besides the content and applicability of inservice activities for beginning teachers, timing is also another important aspect of such learning opportunities. Wong et al. (1999) found that inservice activities scheduled during the beginning of school year are not useful for teachers.

To this point the conversation has focused in general on teacher beliefs and how such beliefs and practices may be transformed during teacher development--a process that can be supported by induction programs and the context of a novice teacher's work. But this research requires a more fine-grained analysis of specific areas of teacher beliefs, and now we turn to discussion of specific aspects of teachers' beliefs--self efficacy and pedagogical discontentment.

The Sense of Self-Efficacy

Bandura (1986) defined self-efficacy beliefs as “people’s judgment of their capabilities to organize and execute courses of action required to attain designated types of performances” (p. 391). As a cognitive concept, self-efficacy beliefs include individuals’ perceptions of their ability to influence and control certain events and situations. Bandura (1989) conceptualizes two types of self-efficacy beliefs: outcome expectancy and personal efficacy. In his definition, personal efficacy is “judgments about how well one can organize and execute courses of action required to deal with prospective situations that contain many ambiguous, unpredictable, and often stressful elements” (p. 201). Conversely, Bandura (1977) defines outcome expectancy as “a person’s estimate that a given behavior will lead to certain outcomes” (p. 201). According to Bandura (1986), efficacy beliefs anticipate successful outcomes. Bandura (1995) exemplifies the relationship as follows:

An efficacy expectation is the conviction that one can successfully execute the behavior required to produce the outcomes. Outcome and efficacy expectations are differentiated, because individuals can believe that a particular course of action will produce certain outcomes, but if they entertain serious doubts about whether they can perform the necessary activities such information does not influence their behavior (p. 193).

Although outcome expectancy and personal efficacy refer to different sets of cognitive skills and dispositions (Bandura, 1995), Pajares (1997) argued that personal efficacy beliefs, in part, determine outcome expectancy beliefs. Individuals who expect success in a particular event predict a successful outcome. Teachers confident in their pedagogical and content knowledge skills expect high success from their teaching. Too often, the opposite is also true. Teachers who doubt their pedagogical and content knowledge dispositions envision a low success outcome from their teaching (Pajares, 1997).

In his attempt to refine the study of teacher efficacy, Pajares (1997) stated that teachers’ self-efficacy beliefs affect their instructional practices and their teaching philosophies toward educational process. For example, Woolfolk and Hoy (1990) find that teachers with low teaching self-efficacy tend to hold a pessimistic view of students’

motivation and thus emphasize strict control of classroom environment and rely on extrinsic artifacts of classroom settings to enhance students' learning. Thus, teachers with low efficacy undermine students' cognitive development (Tschannen-Moran, Hoy & Hoy, 1998). On the other hand, teachers with high self-efficacy are thought to create mastery experiences for their students and enhance student achievement and attitude (Woolfolk, Rosoff & Hoy, 1990).

Based upon Bandura's work describing the relationship between belief and practice, contextual and social constraints might be understood to impede individuals' ability to succeed in specific tasks even when they have the skills and a profound level of self-efficacy to achieve the tasks (Andersen et al., 2004). Similarly, Bandura (1986) indicates, "[P]hysical and social constraints further impose limits on what people can do in particular situations" (p. 396). Consequently, Pajares (1997) also suggested that when social constraints and inadequate resources impede academic performances, self-efficacy might exceed actual performance. Simply said, it is not because individuals do not know what to do; it is because they are unable to apply what they know.

In the discourse of education, when teachers face a lack of social and contextual support, they often find themselves ineffective. Consequently this sense of inefficacy results in stress and burnout in teachers (Zeichner & Tabachnick, 1981). In attempting to understand the contextual influences on teachers' self-efficacy beliefs, Pajares (1997) bemoans paucity of research focusing on the contextual influences of teachers' efficacy beliefs.

Research in Teacher Efficacy

Teacher efficacy is one of the most significant social-psychological factors influencing teachers' practices (Smylie, 1990). Tobin et al. (1994) posit that teacher self-efficacy beliefs strongly influence the nature of a teacher's role, planning, and, consequently curriculum and student learning. In the research in social and psychological disciplines as well as education, Bandura's differentiated self-efficacy beliefs (1986) provide a viable theoretical foundation for this area of study, and indeed, are drawn upon extensively in the design of research instruments for this construct.

The literature directed toward measuring teachers' self-efficacy beliefs is vast. Teachers' sense of self-efficacies plays a significant role shaping teachers' practices (Guskey & Passaro, 1994). Here the literature is replete with quantitative instruments (e.g., Lumpe et al., 2000; Riggs & Enochs, 1990; Ritter, Bone & Rubba, 2001). Some of these instruments take into account contextual aspects as well as social aspects such as students' learning, collegial support, culture and context of school (Andersen et al., 2004).

In constructing teachers' self-efficacy instruments, Pajares (1992) indicates that the researchers have primarily assessed two main dimensions of self-efficacy beliefs originated by Bandura (1977). The first dimension is described as "Personal Teaching" and relates to the teachers' assessment of their own teaching competencies. The second dimension is "Outcome Expectancy," which refers to teachers' expectations that their practices can influence student learning (Pajares, 1992). Blake (2002) reports that close examination of these two sets of constructs link what a teacher believes about his or her ability to teach a subject matter to his or her skills and personal dispositions for having these beliefs manifested in practices. Thus, Guskey and Passaro (1994) elucidate that these two constructs do not represent a personal versus a general teaching efficacy orientation of a teacher; rather they represent an internal versus external distinction within the self-efficacy belief system of a teacher.

Measuring Science Teachers' Sense of Self-Efficacies

One of the most prominent attempts to construct a research instrument for exploring science teachers' self-efficacy is that of Riggs and Enochs. Their instrument, The Science Teaching Efficacy Beliefs Instrument (STEBI) measures both self-efficacy and outcome expectancy of preservice and inservice science teachers (Riggs & Enochs, 1990). Specifically, the preservice version of the instrument (STEBI-B) quantifies the science teaching self-efficacy of preservice teachers (Riggs & Enochs, 1990). Working from Bandura's two main constructs of self-efficacy beliefs, the STEBI-B assessment tool embraces two subscales, namely Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Efficacy (STOE). The STEBI-B consists of twenty-three

items that respondents are to rate on a five-point scale from “strongly agree” to “strongly disagree”.

Ritter, Boone and Rubba (2001) used a science teaching efficacy instrument, which responds to “Science for All Americans” (AAAS, 1989). To ensure scientific literacy for all, Ritter et al. (2001) recognize teachers’ self-efficacy beliefs as a vital factor to address the equity of science teaching highlighted by “Science for All Americans” (1989). Therefore, they indicate that it is important for elementary teachers to understand student diversity and be able to teach science for a diverse student population. The instrument titled Self-Efficacy Beliefs about Equitable Science Teaching (SEBEST) intends to unearth preservice teachers’ orientations toward diverse student identities based upon ethnicity, language, gender and socioeconomic status (Ritter et al., 2001). In contrast to STEBI’s focus, the SEBEST does not regard students as a homogeneous group. Rather its focus is to identify preservice teachers’ personal dispositions and efficacy beliefs toward diverse student population that they might face within their classes (Ritter et al., 2001). Containing eight subscales, the SEBEST consists of thirty-four Likert-scale items that are used to quantify personal efficacy and outcome expectancy subscales scores across four distinct student demographic dimensions (i.e., gender, ethnicity, language, and socio-economic status).

Within the context of current research on science teacher self-efficacy, SEBEST and STEBI are the major data sources of research in science teacher efficacy. However, The Context Beliefs About Science Teaching (CBATS) is another instrument developed by Lumpe et al. (2000) to measure the context beliefs part of personal-agency beliefs. In an attempt to understand the relationship between belief and context, Ford (1992) proposes a “person-in-context” (p. 69) model, which describes the motivational process associated with individual achievement and competency. According to Ford (1992), individuals’ self-efficacy beliefs toward assessment of their ability to perform a given function and helpfulness of the context in that performance are essential originators to action. Further, Ford (1992) indicates that personal capability and context structure the personal-agency beliefs, which eventually determine individuals’ behavior. The CBATS consists of 26 contextual factors that science teachers choose from to say which items they feel would be desirable for successful teaching (enabling factors); then they decide

to what extent each factor is actually present in their situation (likelihood factors). Some exemplary items include professional development on teaching, support from other teachers and administrators, hands-on science kits, planning, permanent science equipment, technology, parental involvement, and involvement of scientists.

However, questioning the effectiveness and usefulness of these self-efficacy measurement tools, Bandura (1986) suggested that quantitative measures of teacher efficacy are insensitive to context and their sole use might minimize our understanding of the actual influence of teachers' self-efficacy beliefs on their teaching practices and student outcomes. Bandura (1997) argued that "efficacy beliefs are multifaceted and contextual, but the level of generality of the efficacy items within a given domain of functioning varies depending on the degree of situational resemblance and foreseeability of task demands" (p. 13). Therefore, Pajares (1992) stresses that although scales or instruments may be useful for understanding the pattern of teacher self-efficacy beliefs and how these beliefs relate to their classroom practices, researchers should endeavor to assess the teacher beliefs that correspond to criteria of interest rather than assess those beliefs with generalized measure. Working from this argument, research in this area needs to use interpretive research methods consistent with quantitative research scales. Munby (1984) suggested that interpretive research methods such as ethnographies, case studies and interviews can provide detailed discovery to how teachers' self-efficacy beliefs may or may not be influenced by student outcomes in their classroom practices.

Self-Efficacy Research in Science Education

Although STEBI-B has been widely used in many studies to measure science teaching self-efficacy and outcome expectancy of preservice and inservice science teachers, it was created over 17 years ago, and there have been few efforts to revisit its internal validity and reliability. Recently, Bleicher (2004) examined the validity and reliability of STEBI-B with two hundred ninety preservice teachers.

A factor analysis established on the STEBI-B by Bleicher were homogeneous and loadings comparable to those reported by Enochs and Riggs (1990). On the other hand, two items on the science teaching outcome expectancy were found to exhibit cross-loading on the factor analysis. These items also illustrated low item-correlation. After

modifying these two items, Blaicher administered a revised instrument to 86 new participants. A factor analysis for the revised instrument illustrated that these two items loaded more clearly on the science teaching outcome expectancy subscale and item-total correlations were observed to be stronger (Bleicher, 2004).

In their study, Settlage, Southerland, and Smith (2006) used the original version of STEBI and SEBEST as well as individual interviews to examine changes in preservice elementary teachers' self-efficacy during college coursework and through the student teaching experience. Settlage et al. (2006) found that change in preservice elementary teachers' outcome expectancies and personal teaching efficacies are different when the teachers are asked to consider diverse student populations. According to their findings, the preservice elementary teachers displayed strong confidence in their ability to be successful at teaching all types of students because they viewed success in teaching as simply engaging the students so everyone participates in the lessons. On the other hand, during the analysis of interviews with a purposeful sampling of the participants, the authors found that although each of the preservice teachers was exposed to diverse classrooms, they were unable to describe specific instructional strategies appropriate for these students (Settlage et al., 2006). The study reveals that preservice teachers hold high levels of self-efficacy; this self-efficacy was incompatible with their abilities. These researchers suggest that preservice teachers' high level of teaching confidence may blind them to the sorts of self-doubt, which might prove to be useful in creating reasons for them to advance and develop professionally. Therefore, Settlage et al. (2006) conclude that preservice teachers' high self-efficacy and high teaching competencies limit these novices in their development toward becoming culturally responsive teachers.

Likewise, Pajares (1992) correlated teachers' low self-efficacy beliefs to the level of their openness to change and improvement in their teaching practices. According to Pajares (1992), the relationship between teachers' self-efficacy and change is individual specific and context dependent. Guskey (1998) claimed that high teacher efficacy can promote or inhibit the conceptual change depending on individuals and the context in which they teach.

Based on the theoretical usefulness of self-efficacy in affecting teachers' practices and the potential significance of culture in influencing teachers' beliefs and their

receptiveness to change, Andersen et al. (2004) sought to further understand belief-context-change interaction. They explore whether or not science teaching self-efficacy beliefs of beginning elementary teachers interact significantly with science teaching and teaching context in their schools. In order to understand the beginning teachers' self-efficacies, Andersen et al. (2004) also used STEBI-B, administering it before the participants start their actual teaching, in the middle of the beginning teachers' first year, and at the end of that first year. During the final administration of the STEBI-B, the authors also applied the Context Beliefs About Science Teaching (CBATS) instrument to find out which enabling factors in a school environment would be desirable for beginning science teachers' effective science teaching. The researchers also utilized observations and interviews to ensure the triangulation of data analysis. Andersen et al. (2004) found that there is a positive correlation between beginning teachers' self-efficacy and the contextual factors. Positive changes in beginning science teachers' self-efficacies seem positively related to the occurrence of environmental factors that are supportive of their teaching (Andersen et al., 2004).

Many researchers (e.g. Andersen et al., 2004; Roberts et al., 2001) indicated that a focus on beginning teachers' efficacy beliefs is important since early success shapes their teaching practices for years; indeed, the self efficacy of experienced teachers is less amenable to change. Tschannen-Moran, Hoy and Hoy (1998) report that although few studies have looked at the development of self-efficacy beliefs of beginning teachers, it seems that self-efficacy beliefs of first-year teachers are related to both stress and commitment to teaching. Drawing on studies conducted by Burley et al. (1991), Tschannen-Moran et al. (1998) indicate that beginning teachers with a high sense of self-efficacy feel greater satisfaction in teaching, have a more positive attitude toward teaching, and experience less stress. Additionally, beginning teachers with high self-efficacy seem to rate the quality of their preparation higher and the difficulty of teaching lower than those who are less efficacious. Also, efficacious novices indicate greater optimism that they would stay in the field of teaching than their less efficacious counterparts who tend to leave the profession because of their dissatisfaction with their teaching experiences (Tschannen-Moran et al., 1998).

Besides teachers' retention, teachers' change toward implementing reform recommendations is another important aspect of teacher self-efficacy. According to Pajares (1997) teachers who are highly confident in their instruction might be highly resistant to change due to the confidence, which they hold in themselves. Conversely, teachers who are highly confident in their pedagogical and content knowledge might also be confident enough in themselves to attempt change in their teaching practices.

Significantly, science education reform literature also reveals a very close relationship between beginning teachers' change and their self-efficacies. Many researchers have indicated that the success of reform in education, particularly in science education, depends on teachers and the beliefs that they hold about teaching (e.g. Anderson, 2002; Bybee, 1993; Cuban, 1990; McLaughlin, 1990; Southerland et al., 2007). Consequently, in their review of science education research, Tobin, Tippins, and Gallard (1994), summarize the necessity to examine teachers' beliefs by stating:

Future research should seek to enhance our understanding of the relationships between teacher beliefs and science education reform. Many of the reform attempts of the past have ignored the role of teacher beliefs in sustaining the status quo. The studies reviewed in this section suggest that teacher beliefs are a critical ingredient in the factors that determine what happens in classrooms. (p. 64)

Related to this call, Czerniak (1990) describes that highly efficacious teachers are more likely to use open-ended, reform-based, student directed teaching strategies, while teachers with a low self-efficacy are more likely to use teacher centered teaching strategies such as lecture and reading from the text. Another study designed by Czerniak and Lumpe (1995) provides an account of the relationship between teacher self-efficacy and science education reform. They examine teachers' perceptions regarding their perceived implementation of science reform in their classes, and they describe teachers' self-efficacy beliefs as a determining factor to their implementations of reform in science classes. For this study including 168 teachers from different grade levels of K-12, Czerniak and Lumpe (1995) used the Science Teacher Belief Instrument (STEBI) mentioned earlier (Riggs & Enochs, 1990) and Innovations in Science Education Survey Instrument (BSCS, 1994). This second instrument measures teachers' beliefs about reforms and their degree of implementation of these reforms. From their data, they

conclude that self-efficacy is related to teachers' willingness or inclination to implement reform recommendations. Unfortunately, they provide little evidence into the nature of this relationship.

Traditionally, many researchers assume positive teacher efficacy as a pivotal variable influencing teacher performance and student outcome (e.g. Guskey, 1984; Ross, 1994; Weasmer & Woods, 1998). Tschannen-Moran, Woolfolk Hoy, and Hoy (1998) explain that "greater efficacy leads to greater effort and persistence, which leads to better performance, which in turn leads to greater efficacy" (p. 234) because teachers' sense of self-efficacy plays a critical role in teacher cognition and motivation, an assertion supported by others in the field (Weasmer & Woods, 1998).

However, the assertion that teachers' positive sense of self-efficacy supports educational reform efforts is under debate. Wheatley (2002) argued that positive teacher efficacy beliefs might actually serve to obstruct reform implementations. This supports the findings of Settlage et al. (2006). Wheatley explains how teachers' sense of self-efficacy interacts with teachers' willingness or inclination to implement reform-based practices. In his study, Wheatley (2002) uses the concept of "teacher efficacy doubts" that is "...to encompass everything from mild uncertainty to profound doubts about one's efficacy, including doubts about specific or general aspects of one's teaching and doubts regarding outcome expectancies, efficacy expectancies, and personal teaching efficacy." (p. 8).

Echoing Settlage et al. (2006), and unlike the common belief on the influence of teachers' sense of self-efficacy, Wheatley (2002) recognized that doubts about one's self-efficacy, in various forms, are sometimes beneficial rather than problematic. In his analysis of reform-minded teacher efficacy research literature, Wheatley (2002) identifies several veins showing that teacher efficacy doubts might aid reform by fostering teacher learning in many ways: inducing disequilibrium and change, fostering teacher reflection, supporting motivation to learn and responsiveness to diversity, and promoting productive collaboration. Additionally, Wheatley (2002) indicated:

...teacher efficacy doubts may reduce the tendency to revert to traditional teaching, guard against dogmatism within reform movements, steer teachers away

from less-promising aspects of reforms, provide useful information to teacher educators and reformers, and help prevent teacher burnout. (p. 16)

According to Wheatley (2002), teachers' attitudes towards the subject matter, the teaching methods for which they doubt their efficacy and the receptiveness of the school culture to teachers' efficacy doubts are the factors that determine whether teacher self-efficacy doubts are beneficial. In order for efficacy doubts to allow teachers to be receptive to reform recommendations, it is crucial that teachers have confidence in their learning efficacy (Bandura, 1989) so that they can learn how to be more effective in their future practices (Wheatley, 2002). On the other hand, it is still unclear under what conditions the teacher efficacy doubts are beneficial for teachers and is supportive of reform. Perhaps Wheatley's notion of efficacy doubts functions as Bandura's (1989) sense of "self-satisfaction." Bandura (1989) recognizes individual's dissatisfaction as a driving force for their self-satisfaction. Bandura (1989) explain that "people seek self-satisfaction from fulfilling valued goals and are prompted to intensify their efforts by discontenting with substandard performances" (Bandura, 1989, p. 1180).

In the next section, I explore a construct that is to be intimately tied to self-efficacy and is an important aspect of teacher beliefs, that is, teachers' discontentment.

Teachers' Self-Efficacy and Pedagogical Discontentment

Although teachers' dissatisfaction is a construct that is derived from the reform literature, there has not been a profound consensus among the educators on what dissatisfaction exactly means or on how teachers' sense of dissatisfaction influences their practices toward reform. Evans (1997) discusses the problem associated with the definition of satisfaction. Traditionally, job dissatisfaction is an affective emotional reaction to a job that results from the mismatch between desired outcomes (Cranny et al., 1992). Nevertheless, Evans (1997) indicates that satisfaction can hold two different meanings: satisfactory and satisfying. She illustrates how within the existing literature, job satisfaction stems from the application of word "satisfaction" which can be expressed as "customer satisfaction." On the other hand, satisfying can be expressed as "satisfaction of having conquered Everest." The ambiguity embedded in the definition of job

satisfaction results in methodological problems arising from conceptual haziness (Evans, 1997). Therefore, Evans (1997) stated,

Because there is lack of agreement over what is meant by job satisfaction, problems of construct validity potentially arise when researchers fail to provide a clear indication of what they mean by the term, or when they fail to clarify how research subjects interpret the concept (p. 321)

Building on the distinction between the meanings of satisfactory and satisfying, Evans (1997) suggested two distinct terms: *job comfort* and *job fulfillment*. According to her definition, job comfort relates to the extent to which individuals are satisfied with, but not by, the conditions and circumstances of their job. On the other hand, Evans (1997) defines job fulfillment as “a state of mind determined by the extent of the sense of personal achievement which the individual attributes to his/her performance of those components of his/her job which s/he values” (p. 327).

In light of these two terms, Evans (1997) defines job satisfaction as “a state of mind determined by the extent to which individual perceives job-related needs to be being met” (p. 328). This understanding of job satisfaction is important to consider to understand a related, but distinct construction: teachers’ discontentment.

Feldman (2000) relates the success of reform implementations to teachers’ discontentment with their current practices. Similar to Bandura’s (1989) original definition, Feldman (2000) argued that authentic change in understanding takes place when teachers “are discontent with their old practical theories and they find the new ones sensible, beneficial, and enlightening” (p.613). Unlike traditional acceptance of the construct of job dissatisfaction, Feldman (2002) uses the concept of “discontentment” as a necessity for teachers to change in order to implement reform-based instructional practices. Discontentment then focuses the discussion not on job related needs, but with the way in which teachers assess their work.

To further this discussion, Gess-Newsome, Southerland, Johnston, and Woodbury (2003) in their analysis of teacher change also speak to this construct. Similar to Feldman (2000), Gess-Newsome et al. (2003) define teachers’ dissatisfaction as a promising requirement for teacher change. Unlike Feldman (2000), Gess-Newsome et al. (2003)

provide detailed accounts of the nature of teachers' satisfaction indicating that the construct has two distinct dimensions: contextual and pedagogical.

Contextual dissatisfaction includes teachers' beliefs about different external aspects of their teaching. Lack of administrative support, lack of supplies, time and space constraints, student characteristics are some of the main reasons for teachers' contextual dissatisfaction (Sowell, Southerland & Granger, 2006). Conversely, pedagogical dissatisfaction occurs when a teacher recognizes the mismatch between his/her teaching beliefs, instructional practices, goals and student learning outcomes (Gess-Newsome et al., 2003).

By focusing on teachers' content knowledge and their sense of self-efficacy, Gregoire (2003) revealed that prior efficacy beliefs and subject matter knowledge are likely to mediate the process of teacher change. Apart from the influence of efficacy beliefs and subject matter knowledge, his work and others reveal that teachers must have a sense of discontentment as a complementary requirement for change (Bandura, 1989; Feldman, 2002; Gess-Newsome et al., 2003; Sowell et al., 2006; Wheatley, 2002). Although some combination of individual sense of self-efficacy and pedagogical discontentment seem to be a requirement for teacher change, there is a paucity of literature addressing the integration of these factors.

Responding to this, Southerland, Sowell, Kahveci, Granger and Saka (2007) attempted to understand the relationship between science teachers' sense of self-efficacy and their discontentment through developing an instrument to measure the construct of science teachers' pedagogical discontentment. Drawing upon the findings of Bandura (1997) and Gess-Newsome et al. (2003), they suggested that a teacher with a combination of pedagogical discontentment and high self-efficacy may be more receptive to reform initiatives within professional development. As argued by Sowell et al. (2006),

To further distinguish pedagogical discontentment, we find it important to highlight the future-oriented nature of the self-efficacy construct: it is the forecast about one's capacity to successfully accomplish a teaching strategy (self-efficacy), a strategy that one believes to have the possibility of increasing student learning (outcome-expectancy). (p. 6)

Consequently, Sowell et al. (2006) posited that the degree of efficacy can be one factor that affects what happens as a result of pedagogical discontentment. These authors suggest that teachers with low self-efficacies are less likely to try new teaching methods to meet the needs of their students, even if they are displeased with the results of their current efforts. On the other hand, teachers with high self-efficacies tend to seek for alternative ways to meet student needs (Sowell et al., 2006). Therefore, these authors suggest that the existence of pedagogical discontentment, combined with high self-efficacy might enhance teachers' engagement with professional development experiences, making them more likely to implement reform suggestions.

Indeed, it is argued that teachers' sense of pedagogical discontentment appears as one of the most influential requirements for teacher change toward reform-based practices (Feldman, 2000; Gess-Newsome et al., 2003; Southerland et al., 2007b). Furthermore, teachers' sense of self-efficacy has been identified as an influential mediator for change within the context of reform (Gregoire, 2003). On the other hand, some researchers argue that high level of self-efficacy might cause teachers to resist change (Pajares, 1997; Wheatley, 2002), while others find a low sense of self-efficacy can result in lack of motivation for teachers to change their teaching practices (Tschannen-Moran, Woolfolk Hoy & Hoy, 1998).

Clearly the relationship between these two constructs is not a simplistic one, and there is a lack of a clear empirical basis that details how teachers' sense of self-efficacy interacts with their pedagogical discontentment in their practices.

Summary of the Literature Review

Recent research studies on the teacher attrition indicate that only about 60 percent of teacher education graduates actually enter the profession. Among graduating teachers, 22 percent leave in their first three years in the classroom, and nearly 30 percent have left the profession by the five year mark (Darling-Hammond, 2000; U.S. Department of Education, National Center for Education Statistics, 1996a). A recent study of Texas teacher recruitment and retention reported that 19 percent of new teachers leave after only one year in the profession "primarily because they fail to get badly needed professional support" (Texas Center for Educational Research, 1999, p. 2). These high

rates of attrition have caught the attention of many researchers, legislatures and state education agencies across the nation and have focused attention on the importance of teacher induction.

Among the many definitions, teacher induction has been defined as beginning teachers' transition from preservice to professionals during their first year of teaching (Gracht, 2001). Literature reveals that this transition is one of the most significant and demanding developmental stages of a teacher career (Gold, 1996; Luft, 2007). During their first year of teaching, Spector (1989) indicates that survival is the primary concern of beginning teachers. Consequently, many researchers agree that beginning teachers need support during their transition into professional practice (e.g., Andersen et al., 2004; Little, 1990; Luft, 2007; Roehrig & Luft, 2006; Stockard & Lehman, 2004).

In many of the studies on teacher induction, science teachers are incorporated with other first-year teachers. However, Lederman and Gess-Newsome (1991) acknowledge the complexity of science teaching, investigating the responsibilities and the roles of first-year science teachers. They found that first-year science teachers face more perplexities than teachers of other subjects because they are required to handle extended instructional planning, development of instructional skills requiring hands-on activities, laboratory activities as well as the routines of school structure.

The science teacher education literature reveals that many of the beginning science teachers enter the classroom with idealistic expectations and teaching and learning beliefs (Simmons et al., 1999). However, after entering the profession, these beginning teachers dramatically change these beliefs. The sources of this dramatic change stem from teachers experiencing: (1) a major developmental transition that entails a significant change from student to professional, the loss of their established support network (e.g., Williams, 2001); (2) a steep learning curve required for the adoption to specific school culture (e.g., Williams, 2001); and (3) "washed out" and "reality shock" effects upon entering the classroom, caused by the struggle with environmental difficulties, issues of translating theory to practice, and adjusting to the expectations and practice of the school (e.g., Veeman, 1984; Zeichner & Tabachnick, 1981).

Sclan (1993) reveals that these experiences might result in a lessening of beginning teachers' willingness to put effort in applying their preservice reform-based

teaching philosophies in the early months of their career. Even further, these factors might cause novice teachers to leave the profession. The more problems a novice encounters, the more likely one is to leave.

To better address beginning teachers' problems, there are two main interests in the recent general and science teacher induction literature. The first interest relates to beginning teachers' beliefs and their influences on novice teachers' induction experiences. The second focus relates to contextual influences such as culture of school, physical features, and collegial and administrative support for beginning teachers' during the induction period.

In the first interest area, researchers suggest that various aspects of teachers' beliefs about science and science teaching and learning tend to determine their teaching methods and strategies (Pajares, 1992; Smith, 2005). Scholars posit that novice teachers construct their teaching philosophies (which are a group of beliefs consistent, coherent and adequate to validate their actions in their classrooms) but they argue that these philosophies are not coherent for all beginning teachers (Simmons et al., 1999). Simmons et al. (1999) indicate that it is through personal actions and social interactions in social environments that beginning teachers organize and construct their beliefs, teaching philosophies and classroom practices. In this manner, change in each beginning teachers' actions and beliefs occur in a specific social context. Therefore, change in beginning science teachers' actions toward reform-based teaching is very complex, individual and context dependent.

Within the second area of interest, researchers describe that beginning teachers' enculturation into schools often hinders or even prevents their professional development as well as their willingness to practice toward reform-based instructions if existing communities and the school contexts are not supportive for these novice teachers (McLaughlin & Talbert, 1993). The contextual factors influence the novice teachers' job satisfaction, which leads them to stay in the profession (Palermo, 2002; Yee, 1990). Blending these differing perspectives, McGinnis et al. (2004) suggest that enactment of reform-based teaching practices is linked both to satisfaction with one's work and thus with their continued retention. It is understood that supportive work conditions increase

the beginning science teachers' satisfaction and eventually help beginning teachers to maintain their use of reform-based practices in science teaching (McGinnis et al., 2004).

Additionally, Bandura's (1986) work related to the construct of self-efficacy is useful in examining beginning science teachers' capability beliefs and their relationship with classroom behavior (Settlage et al., in review). Many researchers indicated that science teachers with high self-efficacy are found to be more likely to facilitate reform-based and student-centered teaching methods for their science teaching; meanwhile those teachers with low self-efficacy are more likely to use traditional teacher-centered teaching methods (e.g., Czerniak, 1990; Czerniak & Lumpe, 1995; Tschannen-Moran et al., 1998).

In contrast to the traditional belief that teachers' satisfaction and high sense of self-efficacy are essential to reform implementation, some other researchers consider teachers' dissatisfaction as a necessary construct for teacher development (Gregoire, 2003). Similarly, Wheatley (2002) posited that some degree of self-doubt in teachers might be useful in advancing school reform and stimulating professional growth. Feldman (2000) also stated that teachers' sense of discontentment in their teaching affects their responses to professional development. According to Feldman (2000) teachers who are highly confident in their instruction might be highly resistant to change due to their own self-confidence. Feldman (2000) describes that teachers must be dissatisfied with their current teaching practices. Similar to Feldman (2000), Gess-Newsome et al. (2003) also value the construct of teachers' dissatisfaction as a promising requirement for teacher change. In their detailed accounts on nature of teachers' pedagogical dissatisfaction, Gess-Newsome et al. (2003) indicate that pedagogical dissatisfaction occurs when a teacher recognizes the mismatch between his/her teaching beliefs, instructional practices, goals and student learning outcomes (Gess-Newsome et al., 2003).

Drawn upon Bandura (1997) and Gess-Newsome et al.'s (2003) works, Southerland et al. (2007b) described how the degree of efficacy interacts with a sense of pedagogical discontentment to influence how a teacher reacts to messages of reform. Southerland et al. (2007b) posited that the existence of pedagogical discontentment, combined with profound self-efficacy, might enhance teachers' practices through their

engagement with professional development experiences toward implementing reform suggestions.

The light of recent literature findings, I argue that it is essential for science teacher educators to more deeply understand what happens to our reform-minded beginning teachers during their first year of teaching. Through this research, I describe the contextual features that shape and mold changes of the teachers, their teaching practice, and their teaching goals during their first year of teaching. Further, I describe how novice teachers learn to negotiate the many, possibly contradictory factors during their induction period and what this means for how science teacher educators, administrators and schools can better support such novices in the enculturation process.

CHAPTER 3

METHODS AND METHODOLOGY

This chapter begins with an examination of methodological issues of research in beginning science teacher induction. This is followed by the introduction of Cultural Historical Activity Theory (CHAT) as the theoretical framework of this study. I also model this research based upon CHAT in this chapter. After methodology section, I provide a detailed explanation about the research methods I employed to conduct this research.

Methodological Issues in Science Teacher Induction Research

Bruner (1999) states that the master question of educational research is threefold: what, to whom, and how. This master question helps educational researchers explore possible ways in which educational objectives might be formulated and carried out in the light of cultural objectives and values in general (Bruner, 1999). However, in educational research literature there are many modes of research designs and various theoretical frameworks, each with its own various purposes and commitments.

Recently research on beginning teachers has focused on various issues: beginning teachers' retention, induction programs for beginning teachers and their effects on novice teachers' professional and personal development, as well as the challenges of beginning teachers and reasons for their attrition from their work.

The nature of research on the induction period also shows diverse methodological bases depending on purposes and motives of the researchers. In order to understand this diversity, it is appropriate to explain that there are two main foci of research on teachers' induction. The first main research frame refers to quantitative research, which aims to explore descriptive aspects of beginning teachers' induction period (e.g. Darling-

Hammond & Sykes, 2003; Ingersoll & Kralik, 2004). The goal of these quantitative research studies is to evaluate different statewide or local induction and mentoring programs in terms of their effectiveness on beginning teachers' retention. With regard to their contribution to the teacher development literature, they provide empirical support for the claim that assistance for new teachers in specific induction programs have a positive effect on beginning teachers' professional and personal development and allows them to overcome the foreseen challenges during their induction period and, ultimately, encourages their retention in teaching.

Despite their contributions, these studies are criticized because of their nature and research procedure. One of the most common critiques, which is relative to all quantitative research studies, is related to large databases and the weighted sampling approach that is taken in the data collection (Strong, 2004). According to this critique, such research procedures might result in emphasized effects of non-response, meaning that findings might represent characteristics of the group that are not representative of the general population. Additionally, this type of research might not be able to provide in-depth understanding about the beginning teachers' individual experiences and the contextual influences on their practices and decision making during induction period.

The second wave of research on beginning teachers addresses the constraints that the former theoretical frames may not take into account. Recently, there has been intensified emphasis on research into the development of beginning science teachers. Previous studies, both qualitative and quantitative in nature, treat all beginning teachers the same. Recent research studies, however, recognize the unique needs of beginning science teachers (e.g. Adams & Krockover, 1997; Luft & Patterson, 2002; Roehrig & Luft, 2006; Yusko & Feiman-Nemser, 2008). With regard to the complex nature of beginning science teachers' development, a review of the literature highlights crucial points of interest when considering science teachers' induction period. These crucial points include beginning science teachers' beliefs, practices and teaching philosophies (Simmons et al., 1999), support programs (Roehrig & Luft, 2006) and mentoring (Yusko & Feiman-Nemser, 2008) professional development (Adams & Krockover, 1997), and contextual influences (Gratch, 2001).

These researchers use different theoretical frameworks in their research to understand beginning science teachers' learning experiences during their induction period. Symbolic interactionism, phenomenology, and naturalistic reform are some of the most common theoretical paradigms in the literature on science teachers' induction period. For instance, Simmons et al. (1999) employ symbolic interactionism to understand the relationship between beginning science teachers' beliefs and their classroom actions through examination of the meanings that beginning science teachers bring to the experience.

According to Simmons et al. (1999), symbolic interaction differs from other perspectives by its approach to socialization. They argue that the socialization of individual self evolves through individuals' perceptions of their own social experiences. For their research, they understand language as a medium through which the members of a social group exchange, negotiate, and construct individual and shared meaning, and thus create social reality. Therefore, their research is based on seeking evidence from the participants' experiences in their own words, their own interpretations of their experiences of a social context, and the interplay of social forces.

Luft and Patterson (2002) employ a mixed methodology to understand the influence of different induction programs on the teaching beliefs, practices, and experiences of beginning secondary science teachers. The quantitative aspect of their research focuses on the trends within and among groups of novice science teachers through the analysis of practice and belief changes. For the qualitative aspect, they use a phenomenological framework that consists of structured and semi structured interviews, observations, and the document analysis. According to their rationale, the purpose of phenomenology is to gain an understanding of how individuals make meaning within a social context. Although phenomenology as a theoretical framework has been useful in identifying research questions and framing research process for researchers, it is criticized by symbolic interactionist researchers because of its attitude toward social context (culture) as our inherited meaning system (Crotty, 1998). Crotty (1998) indicated that phenomenology requires us to engage with phenomena in our immediate world and make sense of them directly. On the other hand, phenomenology tends to ignore individuals' past understandings and experiences as derived from the existing culture.

Conversely, symbolic interaction explores the understandings in culture as the meaningful matrix that guides our lives whereas phenomenology treats culture with a strong measure of caution and suspicion over the understandings (Crotty, 1998).

In order to gain in-depth understanding of individuals' innovative learning experiences within a particular context, significant attention is paid to the social and cultural/historical processes that mediate such outcomes (Cole, 2001). Based on enactment of activity systems, Cole (2001) utilizes a theoretical grounding in Vygotskian Sociocultural Theory to focus on the transformation of mediated action for members of a community.

According to Engestrom (1999), Vygotskian Sociocultural Theory is cyclic methodology for understanding transformations at the individual level, specifically emphasizing the internalization of culturally given higher psychological functions of individuals. However, Engestrom (1999) explains that individuals' challenges are not solely limited by acquiring established culture. Individuals also face situations in which they need to formulate appropriate culture. Because of this ongoing nature of transformation in human lives, Engestrom (1999) suggested that researchers need to develop such a profound research methodology when they enter actual activity systems undergoing such transformations.

In terms of methodology quality, Engestrom (2001) contends that this cyclic methodology approach gives new understanding to the notion of formative experiments designed to analyze an activity under investigation. In this notion, researchers need to be engaged in forming socially new artifacts and forms of practice jointly with their subject, rather than solely forming skills and mental functions in their subjects. Therefore, the validity and generalizability of the results will be decided by the sense of viability, diffusion and multiplication of those new models in similar activity systems.

Engestrom (1999) specifies that some possible key findings and outcomes of such research are novel activity, as well as the introduction of specific intermediate level theoretical concepts and new methodological tools for reflective practice mastery. According to his view, such research outcomes hold promise to bridge general theory to specific practice through exploration and consideration of concrete activities as the main

objects of study. Thus, it is crucial that this methodology implies a radical localism.

Engestrom (1999) stated:

The idea that fundamental societal relations and contradictions of given socioeconomic formation-and thus potential for qualitative change-are present in each and every local activity of that society. And conversely, the mightiest, most impersonal societal structures can be seen as consisting of local activities carried out by concrete human beings with the help of mediating artifacts.... In this sense, it might be useful to try to look at the society more as a multilayered network of interconnected activity systems and less as a pyramid of rigid structures dependent on a single center of power. (p. 36)

In sharp contrast to the generalizability commitment driving much of cognitive science research, this construal of a cultural psychology wave focuses on the formation and sustainability of educational small-scale cultures where variation and localization is promoted. Such situatedness has been found to be absolutely necessary in order to attain local customization and sustainability (Cole, 2001). It is obvious that activity theory (Engestrom, 2001) recognizes the profound influence of the surrounding social context in which the work takes place. By exploring and emphasizing micro-cultures of participants, activity theory asks that researchers interpret the participants of the study through their activities within the research context. Consequently, in promoting the local appropriation of designs by microcultures, sociocultural theory helps researchers using activity theory to deeply attend to and learn to shape the cognitive activities and social interactions constituted by participants in everyday settings during complex interventions (Cole, 2001). Additionally, Paré and Maistre (2006) stated that this theoretical framework holds promises for researchers to figure out culturally grounded improvements in specific settings through the researchers' appropriate understanding of the interaction between the individual and context.

Cultural Historical Activity Theory (CHAT)

As discussed in the introduction, the goal of this study is to gain in-depth understanding of individual beginning teachers' induction experiences and their negotiation strategies used in response to the contradictions embedded the context of

schooling. As a means to a better understand the changes that occur *within* the teacher (or subject in CHAT terms), in this work, I began by specifically focusing on changes in beginning science teachers' sense of self-efficacy and their pedagogical discontentment and how these factors play out in shaping the actions involved in their teaching during this fundamentally important first year of induction into the profession, although as is discussed in the result chapters, another central factor emerged as central to understanding teachers as subjects--identity. I employed CHAT to understand the contextual features that shape and mold the teachers (the subject), their teaching practices (the actions in the activity framework), and their teaching goals (the objects and outcomes of the activity system)

The overarching goal of this research was to explore the interaction of personal and contextual factors during the induction period of reform-minded science teachers and to document how this interaction shapes their enactment of science reform. Additionally, the following research questions guided my investigation:

1. How does the activity system for novice teachers change during the course of their first year of teaching?

What self-efficacy beliefs emerge within each beginning science teacher's activity system and how do these self-efficacy beliefs change during the first year of each participant's induction period?

What pedagogical discontentments emerge within each beginning teacher's activity system and how does this discontentment change during the first year of each participant's first year of teacher induction?

How do changes in self-efficacies and pedagogical discontentment (aspects of the subject of each system) shape or inform changes in both the teaching goals of these beginning teachers (the objects of their activity system) as well as their teaching practices (the actions in this system)?

2. What factors are most influential in shaping and informing the changes to science teachers' activity systems during the first year of induction?

What are most salient components of each beginning teacher's activity system for science teaching?

How do these elements influence the belief system, teaching goals, and teaching practices of each beginning teacher as he/she gains experience in the classroom?

In this research CHAT provided a unique way to examine what happens to reform-minded individual beginning science teachers during their transition from preservice novices into full-fledged members of the teaching profession.

Understanding Novice Learning via Cultural Historical Activity Theory (CHAT)

Seeking the ways to understand human activity in the work place, Engestrom (1999) describes that human activity is eternally comprehensive, mobile, and rich in variations of content and form. It is expected that research in human activity should value and reflect this nature of human activity. Engestrom (1999) explains that because of the richness of human activity, there are some internal contradictions before and during all phases of human development.

Traditionally, a vast and varied psychological and sociological literature has given a great deal of attention to the orienting function of goals and plans, the sequential structure of human action, and the level of regulation of actions (e.g., Frese & Sabini, 1985; Giddens, 1984). Engestrom (1999) argued that these current theories have weaknesses in accounting for the socially distributed or collective aspects as well as the artifact-mediated or cultural aspects of purposeful human action. Additionally, he argued that these theories have not yet allowed for a rich understanding of the continuous and systemic aspects of human functioning, which are endlessly multifaceted, mobile and rich in variations of substance and form (Engestrom, 1999). Consequently, Tikhomirov (1988, as cited in Engestrom, 1999) describes that by focusing on the level of actions, researchers often direct their interest only toward goal achievement and problem solving. By solely focusing on these aspects, these researchers often overlook an analysis of the situational, sociocultural and motivational basis of a system. In this case study, CHAT should help the researcher to identify the problems embedded in human action within the context.

Unlike the current theories, the Cultural Historical Activity Theory describes the interaction between human beings and the material world as dynamic, cumulative, and

transformative (Engestrom, 1999). Indeed, the notion of transformation is a key concept in activity theory; it is transformation of participation in activity that results in learning and development. CHAT considers development as not solely a process of knowledge and skill mastery, but as "becoming a different person" through participation in socially meaningful activities.

By critiquing Lave and Wenger's theory of legitimate peripheral transformation for its temporal dimension, Engestrom and Miettinen (1999) set apart CHAT's notion of transformation:

The theory of legitimate peripheral participation depicts learning and development primarily as a one-way movement from the periphery, occupied by novices, to the center, inhabited by experienced masters of the given practice. What seems to be missing is movement outward and in unexpected directions: questioning of authority, criticism, innovation, initiation of change? Instability and inner contradictions are all but missing. (p. 12)

So, the notion of transformation in CHAT refers to not merely learning, but also development.

Given the explanation that transformation of human practice is highly context dependent, Hasan (1996) explains that activity theory is a useful tool for analyzing revolutionary phenomena, for the study of transformation in human practice. He argued that activity theory is a potentially powerful way to explore the contradictions in a setting and make the contradictions the base for individuals to improve their practices by using the discourse of the cultural historical activity theory as a methodology (Olitsky & Loman, 2002). In terms of CHAT, individuals improve their practices through their participations in an activity system. CHAT reveals learning as a never-ending, spiraling cycle of appropriation, transformation into contradictions, and expansion into new learning activities (Engestrom, 1999). Engestrom (2001) also indicates that contradictions are not necessarily to be avoided, however, because they are the driving force of transformation within an activity system.

CHAT was originated by Russian psychologists Leont'ev and Luria in the Vygotskian tradition (Engestrom, 1999) and further developed with rather different emphases by socio-cultural theorists. CHAT has been used within specific fields of

inquiry, such as learning and teaching (e.g., Moll, 1990) and technology (e.g., Nardi, 1996). Kerr (1997) argued that while Vygotsky was interested in the development of individuals, he was likely more interested in the ways in which individual growth and development was contingent on a wider social and cultural context. The current Russian instantiation of Vygotsky's ideas in activity theory is no less focused on the social, as compared with the still overwhelmingly strong concentration in Western psychology with the individual (Kerr, 1997).

According to Olitsky and Loman (2002), activity theory describes the process through which knowledge is constructed as a result of personal (and subjective) experience of an activity. In a social setting, Hodkinson and Hodkinson (2005) specifically point out that activity theory focuses on what people (subjects) actually do, the objects that motivate their activity, the tools they use, the community of which they are part, the rules that pattern their actions, and the division of labor they take in the activity. Given that CHAT has an explicit account on individuals' development in a work place, as a means of best understanding the changes that occur *within* the teacher (or subject in CHAT terms), I employed the theoretical constructs as outlined in CHAT to understand the contextual features that shape and mold changes in the teachers (the subject), their teaching practices (the actions in the activity framework), and their teaching goals (the objects and outcomes of the activity system).

Modeling the Activity System

For novice science teachers, induction is an important period in their professional development; it is a process that is highly influenced by the context of the teachers' work. Because of the content specificity of induction, in order to better understand this process, it is necessary for a researcher to take into account the socio-cultural context in which beginning teachers' innovative learning takes paces.

Following the work of Vygotsky, Engestrom (1994) proposes a model for understanding systems of distributed knowledge such as cultural historical activity systems. Figure 3-1 illustrates an activity system as described by Cultural Historical Activity Theory.

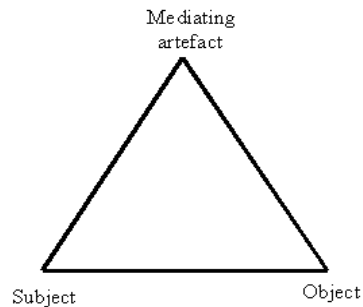


Figure 3.1: Activity System Model (Engestrom, 1999)

Initially, Vygotsky illustrated the idea through a simple triangular relation between the subject, the object and the mediation system (shown in 3-1). The mediation system being the linguistic and cultural (including tools) means by which the communication between subject and object take place. Engestrom stated that activity theory reveals action as a model, which includes all the explicated components and internal relations of an activity system. A simplistic definition of activity model includes four main components, namely mediating artifacts, subject, object, and outcome. Within this simple model, Engestrom specified that each component helps organize the activity system and enhance our understanding of internal relations among the components.

Later on, by distinguishing between action and activity, Engestrom extended this model (as shown in Figure 3-2) to incorporate wider issues including the rules (such as legislative framework and mandated requirement), community (the shared value system of significant colleagues), and division of labor (who is involved in the setting and what are their responsibilities).

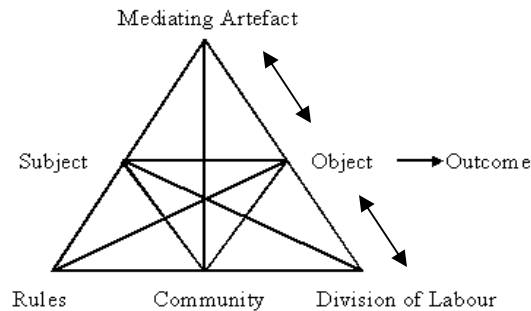


Figure 3.2: Engeström's Advanced Activity System Model

In a desire to develop an advanced model for activity systems, Engeström (1999) indicated that the classical representations of activity system (shown in the Figure 3-1) are limited in their ability to fully explicate the societal and collaborative nature of human action. That is why using this framework, the outcomes of an action appear to be very limited and situation bounded, obscuring the motivation behind the actions.

In order to overcome these limitations, Engeström (1999) expands the model by depicting the structure of an emerging activity system. Compared to the former model, the most significant characteristic of the advanced activity model is that the subject of the model is altered from individual to collective participation in the activity. Engeström (1999) indicates that the central issue of activity theory remains as the object, which is what connects individual actions to the collective activity. In the advanced model shown in Figure 3-2 Engeström (1999) uses rules, community, and division of labor to elaborate the internal relations of the activity system.

Additionally, the notion of mediation in CHAT provides a unique understanding of human actions within a context (Engeström, 1999). Engeström claimed that mediation is not solely a psychological idea. The notion of mediation challenges the Cartesian view, which isolates the individual mind from the culture and society (Engeström, 1999).

Furthermore, he argued that traditionally it is believed that individuals can control their own behavior not only from the inside, on the basis of biological urges, but also from the outside, using and creating artifacts. In this tradition, the origins of individual self-determination are attributed to the biological urges. On the other hand, Engestrom (1999) indicates that activity theory has the conceptual and methodological potential to help humans gain control over their own artifacts and further over their future.

As it is seen in Figure 3-2, Engestrom used double arrow lines between the object and the mediating artifacts, and also between the object and the division of labor. According to his argument, contradictions are not limited by the ones presented in this figure; depending on the nature of an activity system, it is likely to observe possible internal contradictions either within or between the central components of that activity system. The internal contradictions, meaning “areas of conflict” in the system, are driving the forces of change and development (Engestrom, 1999). To better observe individuals’ transformation through change and development processes, Engestrom (1994) suggested the “expansive cycle” model.

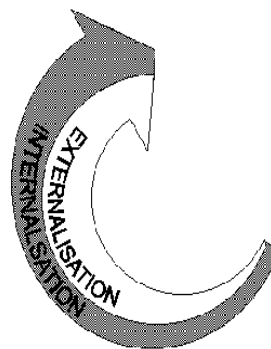


Figure 3.3: Expansive cycle (Engestrom, 1999)

An expansive cycle has two continuous operating processes in the activity system: Internalization, which refers to “reproduction of culture,” and externalization, representing the creation of new artifacts for transformation, shown in Figure 3-3. These two processes form an “expansive cycle,” which leads to transformation of the activity

system. Transformation is learning, and development process functions as a bridge between object and outcome (Engestrom, 1999). Using the expansive cycle model of an activity system, Engestrom explains that the cycle begins with an exclusive emphasis on internalization, which is the socialization and adoptions of the novices as competent members of an activity as it is routinely carried on. Internalization requires novices to adjust to the existing culture. Engestrom (1999) indicates that while the disruptions and contradictions of the activity become more challenging, internalization increasingly takes the form of critical self-reflection and externalization, as a search for possible solutions increases. As it is shown in Figure 3-3, externalization reaches its peak only when a new model for the activity is designed and implemented. According to Engestrom, when the externalization is completed, internalization becomes the dominant form of learning and development. Furthermore, the key feature of expansive cycles is that they are not predetermined paths of one-dimensional development.

By using such activity model, Engestrom stated that rather than analyzing individuals' actions, the model provides a broad analysis of their activity context. Additionally, the model of activity system also highlights the subject community relations as an integral aspect of activity system. Thus, the model enables us to overcome the possible oppositions between activity and communication within an activity system.

In this study my intention is to describe the activity system of two beginning teachers and to explore possible internalization and externalization processes as signs of change and developments in these novices' sense of self-efficacy and pedagogical discontentment. In conjunction with this analysis, I also intend to focus on the possible contradictions that may impede or allow for these expansive cycles.

More specifically, some components of an activity system for beginning teachers' induction include:

- **Subject:** includes two beginning science teachers as well as these teachers' collective participations within the activity systems.
- **Object:** includes the beginning science teachers' teaching goals as well as their teaching practices.
- **Rules:** include the validation system of the district in which the school is located, the rules and regulations of the state for becoming a teacher, the

financial and other incentives to become a teacher, and the rules of the school where the beginning teacher is employed.

- **Community:** includes the culture of school and its values and the value system of the researcher.

- **Division of labor:** includes the role of mentors in the school, the role of induction programs, the role of administrations of both school and district, and the role of other teachers as well as the role of the researcher.

- **Outcome:** includes these novice teachers' becoming competent science teachers and their enactment of science with regard to consistent reform-based practices.

Additionally, in a research setting, as an active member of the activity system the researcher also has responsibilities and influence over the activity systems (Yin, 2003). During the research, my existence in the study context influenced my participants' actions and decision-making. I may have served as a resource for my participants that many beginning science teachers will not have. I consider my existence as a limitation of the research. To address that, I took every measure to understand my role in these science teachers' activity systems. During the research, I kept a separate journal in which I described my interactions with the participants. I further address this issue in the rigor of research section.

In the following section, I explain specific research methods used for understanding the beginning science teachers' activity systems.

Research Design

Throughout this research project, including the design of my research methods, it is important to note that I employed a post-positivist research perspective. The post-positivist approach has emerged following the works of Popper's "Principle of Falsification" and Kuhn's "Scientific Revolutions" (Crotty, 1998).

The Philosophical Foundations

Post-positivism provides an alternative to the positivist traditions and foundations to conducting research. Crossan (2003) posited that for the post-positivist researcher, reality is not a rigid construct; rather it is a creation of those individuals involved in the

research. Simply, reality does not exist within a vacuum, its composition is influenced by its context, and therefore many constructions of reality are possible within that context (Hughes 1994). Additionally, similar to CHAT, a post-positivist framework also recognizes the complex relationship between individual behavior, attitudes, external structures, and socio-cultural issues. Within this complexity, the post-positivist approach assumes that reality is multiple, subjective, and mentally constructed by individuals (Crossan, 2003). Crossan (2003) suggested that the use of flexible and multiple methods is desirable as a way of studying a small sample in-depth over time that can allow researchers to understand emerging realities as opposed to absolute truths. To ensure the rigor of a research, the post-positivist approach emphasizes the importance of multiple measures and observations, each of which may possess different types of error, and the need to use *triangulation* (Bogdan & Biklen, 1998; Crossan, 2003) across these multiple data sources to attempt to better understand reality, recognizing that given our perceptual filters one never actually describes this reality, but this quest does form a regulatory ideal of post-positivistic research.

Overall Research Design

Bogdan and Biklen (1998) explain that a study aiming to understand the complex nature of context and its influences on individuals requires a detailed examination of context. Therefore, Taylor and Bogdan (1998) suggest “the use of a qualitative research approach since it offers ways of understanding social phenomena from the actor’s own perspective and examining how the world is experienced”(p. 3). Given my research questions, the lack of clearly formal hypothesis, and the inductive nature of the investigation, this study is primarily qualitative in nature, but it includes both qualitative and quantitative data collection and descriptive analysis.

A look at the literature review reveals that there are many kinds of qualitative research methods. According to Maxwell (1996), some of the qualitative research methods are qualitative evaluation, participatory action research, case study, multiple case study, collaborative research, constructivist research, critical ethnography, feminist research as well as practitioner research and so on. Each of these qualitative research methods has its own specific purposes, methodologies and ethics.

Crotty (1998) stated that the roles of researcher and participants define the characteristics of the study. In the past decade, qualitative research methods have become an increasingly important mode of science and mathematics educational research (Schaller & Tobin, 1998). According to Schaller and Tobin (1998), research in science education is concerned with educational stakeholders and their relationship with themselves and their environments. In addition, they suggest that in order to understand these relationships embedded in the research environment, the selected research method should help the researcher to reach all descriptive, analytical, and interpretative phases of the setting under investigation.

Additionally, Stake (2000) stated that for an in-depth examination of a selected group, qualitative case study is an appropriate way to design research. In terms of case studies in beginning teacher induction, Wong et al. (1999) suggested two benefits of using qualitative case studies: (1) case studies can be considered as the first-hand reports of real life experiences of beginning teachers during their induction and; (2) they are used as prototypes for similar frameworks to inform the development of new priorities for beginning teachers. Tickle (1994) also indicated that since the main goal of a successful induction programs is to promote the novices' reflection of their own practice, case studies can be of great assistance to this reflection process. Additionally, Wolcott (1992) suggested that a case study might be regarded as a proper outcome for reporting various types of qualitative and quantitative work. Therefore, because this study consists of the examination and description of two individual beginning science teachers' induction experiences within the unique contexts of their practices, I employed a case study method.

Research Participants

For this examination of the novice science teachers' activity systems, I undertook multiple case studies. According to Wong et al., (1999) such a study should not include more than four primary participants; keeping the sample size small aids the researcher in gaining in-depth understanding from the participants, allowing for a closer focus on their individual experiences. Too, Wiersma (2000) suggested that in qualitative research, the researcher should underscore the importance of purposive sampling in order to collect

adequate information and understanding from the participants. Creswell (1994) also stated that by the purposeful sampling, the researcher selects the participants who can provide in-depth, insightful information. Therefore, for this study, I purposefully selected the participants to better explore the novice science teachers' activity systems during their induction period.

The factors informing my purposeful sample came from the literature on science teacher education induction programs. As discussed earlier, although the induction process is a highly variable and reflects an individual developmental process (Bullough, 1992), the induction period of each beginning teachers should be conceived within the larger context of schooling (Smith, 2005). As such, it can potentially represent a means of broader educational systemic reform, not just a period in which beginning teachers require additional assistance. Additionally, Klepper and Barufaldi (1998) state the importance of studying individual beginning teachers as they envision each beginning teacher as a pioneer of the long-term, profound changes required for the reform of science teaching. Therefore, a priority for participant selection was the inclusion of those teachers who were reform-minded and held the intention to implement reform-oriented practices in their classrooms during their first year of teaching. It was my goal to understand the interaction of personal and contextual factors during the induction period of science teachers and how this interaction shapes their enactment of science reform. I attained this goal by purposefully selecting two reform-minded first year science teachers from the same science education program who selected very different settings for their induction year: an urban high school and a suburban middle school. By exploring the institution where they were certified as science teachers, I was able to understand whether they had internalized and externalized (Engestrom, 1999) their reform-based preservice experiences, and to understand how their teaching context influenced their enactment of these understandings of teaching.

The participants, Nathan and Bob, were selected on the similarities and strengths evidenced during their teacher preparation program: both candidates had strong content preparation, were engaged and knowledgeable about science education reform, and experienced some success teaching in reform minded ways.

Both Bob and Nathan were white, from middle-class homes, and from families that valued education. In this regard they were very similar to many graduates of secondary science programs. Although the two participants had similar preparation, they each chose very different sites for their first year teaching, with very different support infrastructures for first-year teachers: Bob selected a collaborative, suburban middle school and Nathan selected a more individualistic, urban high school.

Moreover, in order to ascertain a complete understanding of beginning science teachers' activity system, I needed to come to an understanding of the community in which these teachers work. Thus, my participants also included other people in the context of the novice teachers: their mentors, principals, coworkers and these novice teachers' university professors.

Teacher Professional Development Program

The two participants in this research were graduates of an undergraduate science education program housed in a large research university in the Southeastern United States. Much of the undergraduate science education program emphasized current reform efforts, as described on the program's website

American Association for the Advancement of Science (AAAS) and the National Science Teachers Association (NSTA) whose membership includes scientists, science educators, and science teachers, have established a shared vision for science education, one that emphasizes the utility of scientific knowledge. These reforms are not designed simply to better allow students to excel on standardized tests, although they may. Instead, the reformers argue that science education should help students learn the necessary knowledge, skills and understanding to our students so they can actively and productively confront the challenges their futures will hold, and this premise is described in the following points:

- (1) The goal of education is to "prepare people to lead personally fulfilling and responsible lives" (AAAS. 1989, p xiii).
- (2) This goal is to be achieved by ensuring that students become scientifically literate. As described in the *National Science Education Standards (NRC, 1996)*,

science literacy. . . means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences...can describe, explain, and predict natural phenomena...can read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions. Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately" (NRC, 1996, p. 22).

Scientific literacy requires a deep understanding of a core number of foundational concepts of scientific knowledge as opposed to a superficial recognition of a wide range of scientific facts.

- (3) There is a strong emphasis that *all* students need to become scientifically literate: "The world has changed in such a way that science literacy has become necessary for everyone, not just a privileged few: science education will have to change to make that possible" (AAAS, 1989, p. xvi).
- (4) The method of *inquiry* is central to reform for science education. Students should understand how scientific inquiries are conducted and how these processes shape the knowledge produced. The reformers argue that inquiry should be one of the fundamental means through which students' science learning is accomplished.
- (5) The reforms describe the need to understand the knowledge students bring with them into the classroom, and to build from this knowledge in order to construct new scientific understandings. The reforms recognize that student science learning can be difficult, complex, and requires a great deal of energy and support. (Program's website)

The science education program included four associate professors with different interests who worked with instructors, graduate and undergraduate students. The

program offered five areas of certification including: (1) middle school science; (2) earth/space science; (3) chemistry; (4) biology; and (5) physics for future science teachers. The undergraduate program included seven undergraduate level courses, three science methods courses (each having a 30 hour field requirement), and clinical field experience courses emphasizing the theories and practices associated with the national reform efforts in science education. The participants of this study were selected because they were the most reform- minded and promising science teacher candidates emerging from the program in recent history (as judged by the program's instructors).

Methods of Data Collection

For this study I used multi-case studies (Bogdan & Biklen, 1998) in which two beginning science teachers' first-year activity systems and related beliefs were examined, described, analyzed and compared. Bogdan and Biklen (1998) suggest that for case study investigations, the major data-gathering technique is participant observation supplemented with formal and informal interviews and document analysis.

It is important to note that data collection and analysis go hand in hand in a qualitative research (Patton, 2002). It is, however, a question that often arises how long a researcher should continue data collection and analysis. Strauss and Corbin (1998) argued that within the constant comparison method of analysis procedure, the general rule when building a theory is to collect data until each category is saturated. Strauss and Corbin (1998) suggested that a researcher should continue data collection until all categories are theoretically saturated, meaning that data collection and analysis continue until: "(1) no new or relevant data seem to emerge regarding a category; (2) the category is well developed in terms of its properties and dimensions demonstrating variations; and (3) the relationships among the categories are well established and validated" (Strauss & Corbin, 1998, p. 212). Without theoretical saturation, the theory is unevenly developed and lacking density and precision. I collected and analyzed my data mindful of the construct of theoretical saturation and only withdrew from the participants once that state was reached in my understanding of both.

The research began prior to the 2005-06 school year in order to describe the teachers' goals and intentions at the outset of their induction year. Data collection

included surveys, questionnaires, interviews (with participants and their coworkers/administrators/professors), classroom observations and school observations. More detail about the focus of these various data collection tools is found in **Table 3.1**.

Table 3.1: Data collection tools and topics

Surveys

1. Science Teaching Efficacy Beliefs Instrument (STEBI) (Riggs & Enochs, 1990)
2. The Context Belief About Science Teaching Instrument (CBATS) (Lumpe et al., 1990)
3. Pedagogical Discontentment Instrument (Southerland et al., 2006)

Open Ended Questionnaire

1. Teaching Philosophy and Background
2. Beliefs about Teaching and Learning Science
3. Beliefs about Science Education Reform
4. Self-Efficacy Beliefs
5. Pedagogical Discontentment
6. Context
7. Site Administration
8. University Professor
9. Mentor Teacher

Primary participant interviews (informal and semi-structured)

1. Background (Structured, 1 for each participant)
 2. Teaching Philosophy and Beliefs (Structured, 3 for each participant)
 3. After Class Observation (2 for each participant)
 4. General School Context (1 for each participant)
 5. Pedagogical Discontentment (3 for each participant)
 6. Self-Efficacy (3 for each participant)
 7. Beliefs about Reform (3 for each participant)
 8. Mentor Teacher (1 for each participant)
 9. Group interview (1)
 10. Emerging Interviews (Addressing Contradictions) (2 for Nathan and 2 for Bob)
 - Accountability and Standardized Testing
 - Interviews those were specific to their practices and communication with other community members including students, administration, students as well as parents
-

Table 3.1: Continued

Other Interviews

1. Site Administration (1 for Bob's case)
 - During this interview we talked about the school norms and expectation from teachers' especially beginning teachers. Additionally, this interview helped me to understand the effectiveness of leadership and its perception about beginning teachers especially beginning science teachers' induction period.
 - The goal of this interview was to better understand the broader activity system of the school context in terms of the cultural capital, history and institutional characteristics of the school context may hinder or support beginning science teachers
2. Mentor Teacher (2 for Bob)
 - During these interviews, we talked about the mentor teachers' overall perception about what they do to assist beginning teachers. Additionally, it was at the center of our talk that how these teachers interact with their mentors and what sort of help that they received during their first year in teaching.
 - To understand the interaction between these beginning science teachers and their mentors as an account for the available support and effectiveness of this support
3. Coworker (1 for each case)
 - We talked about the general context where these teachers spent their first year and how these contexts helped or hindered these teachers' effective transformation to teaching profession. These interviews were also helpful to understand these beginning teachers identity formation through an emphasis on their receptiveness to the support sources including other experienced teachers' suggestions.
 - To understand the dynamics of the school site through a close emphasis on the community of practice and its perception about beginning science teachers
4. University Professor (1 for each case)
 - The theoretical and practical underpinnings of the program in which these two teachers received their undergraduate degree in science education. The expectations of program graduates and availability of follow up professional development opportunities available.
 - To better understand the theoretical and practical learning experiences of these beginning science teachers.

Classroom Observations

1. Physical Environment (1 for each case)
2. Teaching Observations
 - General Teaching Observations (4 for Bob and 4 for Nathan)
 - Full Unit Teaching Observation (8 for Bobs and 5 for Nathan)

School Observations

To better understand cultural capital and institutional structure of the school contexts where these teachers spent their first year in teaching several informal observations conducted during the course of the study (cafeteria, main desk and teachers' lounge)

Data Sources

In this study I employed multiple data sources, including surveys, questionnaires, observations, interviews and mediating artifacts. By employing multiple data sources, I entailed a detailed description of the setting of each activity system of my participants. Therefore, the triangulation of data involved analysis of numerical data, questionnaires, observations, interviews, and mediating artifacts. It would be necessary to note that although this research mainly relied on classical qualitative data sources, including participant-observations and interviews, to better understand the change in the beginning science teachers' sense of self-efficacy, and pedagogical discontentment I also employed self-efficacy surveys, self-efficacy questionnaire, and a pedagogical discontentment questionnaire.

The following matrix describes how I organized and facilitated data collection methods to answer my research questions along with the rationale for using such methods of data collection. Additionally, the surveys and questionnaires are available in the appendices.

The next section explains each data collection method in detail.

Self-Efficacy Surveys

The literature reveals that Bandura's (1986) work related to the construct of self-efficacy has been useful in examining science teachers' capability beliefs and its relationship with classroom behavior. Employing Bandura's theory, Riggs and Enochs (1990) developed an instrument to measure efficacy of teaching science. They state, "A specific measure of science teaching efficacy beliefs should be a more accurate predictor of science teaching behavior and thus more beneficial to the change process necessary to improve students' science achievement" (p. 627). Therefore, Riggs and Enochs (1990) created the *Science Teaching Efficacy Belief Instrument* (STEBI-A) containing two standardized scales titled the *Personal Science Teaching Efficacy Scale* (PSTE) and the *Science Teaching Outcome Expectancy Scale* (STOE). The Self-efficacy scale measures the degree to which a science teacher believes that they **can** succeed in teaching science. The outcome expectancy scale is used to measure the degree to which a science teacher expects their students' outcome to succeed (that they can influence learning) as a result of

their teaching. In most applications, the STEBI consists of 25 items with a 5-point Likert-type scale including “Strongly Agree” to “Strongly Disagree”. Originally, STEBI-A was designed to measure inservice science teachers’ self-efficacy. Also another science teachers’ self-efficacy instrument, The STEBI-B has a partner, form STEBI-A, that is designed to measure preservice science teachers’ self efficacies.

Indeed, drawn on Bandura’s (1997) theoretical orientation of social cognitive theory, several self-efficacy instruments have been created in the field. For example, *The Context Beliefs About Science Teaching* (CBATS) is another instrument developed by Lumpe et al (2000) to measure the context beliefs part of personal-agency beliefs. Researchers using the STEBI have provided evidence to support the assertion that the environmental context plays a role in shaping a science teacher’s beliefs (Andersen et al., 2004; Haney & Lumpe, 1998). The CBATS consists of 26 contextual factors that science teachers choose from to say which items they feel would be desirable for successful teaching (enabling factors); then they decide to what extent each factor is actually present in their situation (likelihood factors). Some exemplary items include professional development on teaching, support from other teachers and administrators, hands-on science kits, planning, permanent science equipment, technology, parental involvement, and involvement of scientists.

To understand the relationship between self-efficacy and context, the CBATS has been recognized as partner instrument of the STEBI. Ford (1992) provides a theoretical foundation of possible interactions of self-efficacy beliefs and context. According to Ford (1992), there are two types of beliefs that are critical for an individual’s effective functioning: capability and context. Capability beliefs include an individual’s perceptions of whether they possess the personal skills needed to function effectively. And, context beliefs include an individual’s perceptions about how responsive the environment was in supporting effective functioning. Ford indicates that capability and context beliefs combine to form personal agency belief patterns that motivate individuals to reach desired goals.

Therefore, I used both STEBI-B (Appendix A) and CBATS (Appendix A) self-efficacy questionnaires at three different points over the course of this research project. Since one of the foci of this study was to understand the change in beginning science

teachers' self-efficacy beliefs, and also to understand the factors exerting the most influence in these changes, I administered these two instruments at three different times. Once before the participants begin their first year of teaching, but after their professional preparation (Summer 2005), again in the middle of their first year (Winter 2005) and finally at the end of that first year in late Summer 2006.

Additionally, I used a questionnaire derived from Haney and Lumpe's (1998) work to support numerical data on beginning teachers' self-efficacies. The description of the questionnaire is in the following section.

Table 3.2: Relationship of Research Question to Data Collection Matrix

Research Questions	Purpose	Method	Rationale for the method
What self-efficacy beliefs emerge within each beginning science teacher's activity system and how do these self-efficacy beliefs change during the first year of each participant's induction period?	To understand the beginning science teachers' sense of self-efficacy during their induction period, and explore the possible changes occur over the time and partly exploring the context-self efficacy relationship	STEBI-B Survey CBATS Survey Self-Efficacy Questionnaire Interview Mediating Artifacts	STEBI-B and CBATS provides numerical, primary information about the change in beginning science teachers' sense of self-efficacies. Additionally, the self efficacy questionnaire supplemented by interview and mediating artifact data, change in these novices self-efficacy can be better understood.
What pedagogical discontentments emerge within each beginning teacher's activity system and how does this discontentment change during the first year of each participant's first year of teacher induction?	To understand the beginning science teachers' sense of self-efficacy during their induction period, and explore the possible changes occur over the time.	Pedagogical Discontentment Questionnaire Interview Mediating Artifacts	The pedagogical discontentment questionnaire is designed to understand teachers' pedagogical as well as contextual discontentment. Data gathered from interviews and mediating artifacts can support initial finding and give opportunity to explore change in these beginning teachers' pedagogical discontentment

Table 3.2: Continued

Research Questions	Purpose	Method	Rationale for the method
How do changes in self-efficacies and pedagogical discontentment (aspects of the subject of each system) shape or inform changes in both the teaching goals of these beginning teachers (the objects of their activity system) as well as their teaching practices (the actions in this system)?	To understand how beginning science teachers' sense of self-efficacy and pedagogical discontentment interact with each other, and how this interaction influences their teaching practices, particularly their enactment of reform	Interview Observation Mediating Artifacts	Data retrieved from the combination of interviews, observations and mediating artifact can provide an in-depth understanding about how the changes in self-efficacy and pedagogical discontentment influence these beginning teachers' teaching goals and their reform enactment during their induction period.
What are most salient components of each beginning teacher's activity system for science teaching?	To understand each beginning science teacher's activity system with respect to CHAT components including subject, object, communities, mediating artifacts, rules, division of labor and outcomes	Observation Interview Mediating Artifacts CBATS Survey	Through observations, interviews and mediating artifacts, we can explore the salient components of each beginning teacher's activity system for their first year science teaching. In addition, CBATS facilitated during and at the end of the school year, also provides an understanding about the contextual factors embedded in novice science teachers' activity system.
How do these elements influence the belief system, teaching goals, and teaching practices of each beginning teacher as he/she gains experience in the classroom?	To understand how beginning science teachers' experiences are being shaped by the activity system elements during their induction period	Interview Observation Mediating Artifact	After the identification of most salient components of each beginning teacher's activity system for science teaching, by facilitating interviews, observations and mediating artifacts, we can understand particular influences of these factors over the beginning science teachers' belief systems, practices and their teaching goals.

Open-Ended Questionnaires

Understanding individuals' experiences and learning in an activity system is a principal aspect of the CHAT (Engestrom, 1999). Along with the historical aspect of CHAT, by understanding the historical aspects of the school in relation to science teaching of these novice teachers, it was essential to explore these novices' understanding of science teaching from their own experience. In order to ascertain the participants' preservice experiences related to their sense of self-efficacy, I employed a questionnaire (see Appendix B) originated by Honey and Lumpe (1998). The questionnaire consists of eleven questions targeted to gain in-depth understanding about the beginning teachers' capability and context beliefs regarding effective science teaching right before their transition to the teaching profession. One of the example questions from the questionnaire is "Tell me about any positive or negative college course experiences you've had related to learning science".

Another goal of this study was to understand the change in the beginning science teachers' pedagogical discontentments and the most influential factors shaping these changes. For this purpose, I used a pedagogical discontentment questionnaire (Appendix B) developed by Southerland et al. (2007b). In their attempt to develop a construct for science teachers' pedagogical discontentment, they used a questionnaire aimed to understand underlying components of pedagogical discontentment. In this questionnaire, Southerland et al. (2007b) employed six open-ended questions for science teachers, questions targeted to identify the teachers' pedagogical discontentment. One of the example questions of pedagogical discontentment questionnaire is "How would you know/recognize when something is *not* successful/effective in your classroom? What signs would you look for?"

In order to understand the change in beginning science teachers' self-efficacies and pedagogical discontentments during their induction period, I applied both pedagogical discontentment and self-efficacy questionnaires, at three times, once before the participants begin their first year of teaching, but after their professional preparation (Summer 2005), again in the middle of their first year (Winter 2005-5) and finally at the end of that first year in late Spring 2006.

Interviews

Bogdan and Biklen (1998) recommended the use of interviews to gather descriptive data in the participants' own words, so that the researcher can develop an understanding of the participants' own reflections on the issue. According to Marshall and Rossman (1989), the nature of interviewing allows researchers to get a large amount of data from a large number of subjects quickly. Interviewing also allows the researcher to justify his/her interpretations when it is combined with observations (Marshall, & Rossman, 1989). In-depth interviewing is more like conversation than formal structured interviews. However, formal interviews are more structured interviews for which the researcher provides the participants with predetermined questions (Marshall, & Rossman, 1989).

According to Bogdan and Biklen (1998), when a study involves extensive interviews or when interviews are the major technique for collecting data, videotape recording is the most appropriate way to capture all statements of participants. Therefore, I recorded all interviews. It is important to note that during audio recordings of classroom observations I was careful to not to record students in the context respecting the constraints of the local school district. After each interview, I carefully transcribed all interview records immediately so that I was able to recall the origin of the conversations. Therefore, transcribing audiotape interview data into field notes helped me to organize my data and retrieve the specific segments throughout the study.

Keeping in mind that I was not able to have exact interview questions for each interview participant, I was aware that the nature of conversation generated the questions that I asked during each interview session. Although the nature of the conversation changed the order of the questions for each case, I mainly categorized my interview questions depending on the main focus of the interviews. Therefore, the following are some of the interview sections that I facilitated during the research.

Before the start of the school year, I had initial interviews with each participant to generate a primary communication between the participants and myself to inform each participant about the nature of the study. During the initial interviews, I informed my participants about what I was doing in their classrooms. Additionally, initial interviews

were a profound occasion for me to schedule the observation times with the research participants.

A second set of formal interviews were designed to understand the participants' current views and their philosophies on teaching and learning science. During the science teaching philosophy interviews (see Appendix C), my intention was to explore the participants' personal teaching beliefs and philosophies by exploring their initial teaching and learning experiences such as their learning experiences during preservice and before, and their student teaching experiences. Bullough (1989) asserts that teachers' past experiences have a great influence on their current vision about teaching and learning. In addition, the science teaching philosophy interview was employed as a complementary data source for the data retrieved from self-efficacy and pedagogical discontentment instruments. During the science teaching philosophy interviews, I used an interview protocol (Appendix C) adapted from the study of Settlage et al. (2004). The original self-efficacy interview protocol is designed to investigate preservice elementary science teachers' attitudes toward teaching science in diverse settings (Settlage, 2004). An example question entailed with the questionnaire is: "What are your feelings about this experience (student teaching)? Do you feel successful? What accounts for this?"

Furthermore, throughout the 2005-2006 school year, it was my goal to facilitate informal interviews conducted approximately every 2 weeks during the school year. During these interviews, I specifically focused on emerging issues retrieved from field notes based on previous interview and observation transcripts. These interviews supported or challenged my interpretations from the observation data, particularly on identifying the influential factors over change in these beginning teachers' self-efficacy and pedagogical discontentment. Also, I scheduled these weekly-based interviews to address possible critical incidents that might arise over the time. The interview protocol for these interviews was shaped in light of the emerging issues during the school year.

Table 3. 3: Schedule for Primary Participant Interviews

	Beginning of the 2005-2006 School Year	During the 2005-2006 School Year	End of the 2005-2006 School Year
Initial Interviews	X		
Introduction and Scheduling			
Science Teaching Philosophy Interviews	X	X	X
Weekly Interviews		X	
Community Members Interviews		X	
Exit Interviews			X

Moreover, I conducted exit interviews with each participant to evaluate the learning process and to assess the research findings on the changes in the participants' self-efficacy and pedagogical discontentment. Through the exit interviews, I focused on the beginning science teachers' overall feelings about their induction experiences. The interview protocol for exit interviews was based on both my and my participants' experiences over the time. An example of the exit interview question was "What was the most challenging experience of your first year in the teaching profession, and what was the most influential factor which hindered/supported your adaptation during this time?"

In addition, I scheduled interviews with other community members within each beginning science teacher's activity system. During the interviews with site administrators, I specifically focused on the administrators' attitudes toward supporting these novice teachers, and their roles within the activity system. Likewise, the site administrator interviews, the interviews aiming to explore other community members such as coworkers, mentors focused on these community members' attitudes and their interactions with these novices. During the interviews with the community members, I used specific interview protocols (Appendix C) adapted from Smith (2002)

Furthermore, within the activity systems of these novice teachers, Bullough (1989) indicates that the induction of beginning teachers is a transition period from preservice to inservice. Therefore, to better explore the beginning science teachers' activity system during their first year of teaching; I extended my understanding by

including these beginning teachers' university professors into the study. Through interviews with the university professors, I understood the preservice experiences of these novices by particularly focusing on reform-based preparation activities and method courses. (See Appendix C for an example of the interview protocol employed.)

Participant Observations

The intent of my observations was to understand more deeply the context in each case. I employed Spradley's (1980) notion of participant observation for my observations. According to Spradley (1980), participant observers must have a wide-angle awareness to approach social life in order to gain a broader spectrum of information.

Additionally, Goodson & Mangan (1991) argue that extensive observations, beyond intensive interviewing, are required in a research setting. Yin (2003) indicates that data collection through participant-observation enhances the credibility of a whole case study.

In terms of inquiry-based contexts, to better understand how these teachers' practices in their first year in teaching were consistent with their preservice learning I used Abrams, Southerland and Evans (in press) recent work in which they outlined necessary components of inquiry-based learning contexts. In spite of the ambiguity of clear cut definition of inquiry-based science education, their extended literature review illustrates that inquiry a central component of all efforts to improve science education. According to their multidimensional definition, inquiry is

Any cognitively appropriate activity that echoes some subset of the practices of authentic science in which students are expected to engage with resources (literature, people, environment) around the generation or answering of questions or the solving of problems. (p.30)

The multidimensional nature of inquiry includes five composite axes; (1) logistical, (2) socio-cultural, (3) cognitive ability/literacy, (4) nature of the content and (5) goals. For Abrams et al. (in press), any empirical investigation in a search for inquiry in classrooms should be systematic, rigorous and detailed in the ways we describe the inquiry events.

During regular classroom observations from September to June, I initially focused on the context of each beginning teacher's case by identifying the actors, activities and objects at a level where the context can be pictured. During these observations, besides identifying actors, activities, and objects, I also tried to understand the physical features of each activity system in which the key individuals interacted with each other. Following this identification, I subsequently concentrated on illuminating the roles of each actor, activity, and object in the research settings. Once gaining sufficient understanding of their roles, it was my primary purpose to acknowledge the relationships among them. To achieve that, Olitsky's notion of positive emotional energy and effective interaction rituals (Collins, 2004) in science classroom particularly helped me to recognize the interactions between these novice teachers and their students (Olitsky, 2005). The nature of interactions that these teachers generated in their classroom aided my understanding of how these teachers promoted their students' engagement in science through their use of effective interaction rituals and pursuit of community of practice in inquiry-based classroom context.

Beyond the specific classroom observations focusing on these novices' teaching, this notion also helped me to understand these teachers' interaction with other community members and their identity formation within the school communities. Observations based on Olitsky's notion facilitated my understanding of the impact of emotional energy that each school community generated through their interaction rituals on these teachers' development and identity formation.

In addition to my observations I kept detailed field notes and facilitated my observations with accordance to an observation rubric. (See Appendix D for the observation rubric). The rubric was created by Smith (2002) for her dissertation study on the relationship between beginning elementary teachers' beliefs and context of practice. These observations included a week of full-day observations for each of my participants, to observations over an entire unit of instruction, and more occasional observations as well as more occasional observation. This assortment of observations provided me with an in-depth understanding of the beginning teachers' activity system of their first year teaching experiences.

Mediating Artifacts

The idea of mediation has its roots in the work of Vygotsky, where tool systems (implying a specific human activity) and sign system (language, writing, number system) mediate by behavioral transformations to higher forms of individual development (Vygotsky, 1978). As a crucial component of mediation in CHAT, in the study, I incorporated mediating artifacts as valuable data sources. Documents are written or printed materials that have been produced in some form or another- annual reports, circulars, court records, diaries, diplomas, legal records, newspapers, magazines, notebooks, school yearbooks, memos, tests, email messages, faxes, or even relics (i.e., furniture, artwork, clothing, buildings) and so forth (Fraenkel & Wallen, 1996; Patton, 2002). In terms of their contributions, Miller (1997) stated that texts are socially constructed realities and are one aspect of sense-making activities through which human beings construct, sustain, contest and change their senses of social reality.

Because of their overall value, mediating artifacts play an explicit role in any data collection in case studies. Yin (2003) stated that systemic searches for relevant documents are important in the data collection plan. During the document selection, my primary purpose was to reach primary documents, which were beginning science teachers' own materials such as their lesson and unit plans, and reports as well as textbooks and lab manuals. Moreover, based on applicability, I also collected secondary documents, including written administrative documents, such as beginning teachers' progress reports, proposals, letters, memoranda, agendas, notices for students and parents and announcements for beginning teachers. In addition to these official documents, I asked these beginning science teachers to keep informal weekly journals to reflect on their weekly practices. However, because of their own responsibilities, they were not able to fully participate in this activity. Additionally, during the research I communicated with my participants electronically. I collected these e-mails and consider them as documents to be analyzed.

Local newspapers and related newspaper clippings as well as other articles appearing in the mass media or in community newsletter as well as World Wide Web were also possible artifacts that I used in this study. As a matter of fact, accuracy of documents is understood to be one of the most important validity criteria of document

analysis (Patton, 2002). Hence, while collecting these artifacts, I emphasized understanding the accuracy of documents through assessing how and why they existed.

Summary for Data Collection

Each source of data previously discussed was transformed into actual data for analysis. Primarily, I collected each data into three main categories; therefore, such processes eased the management of the great body of data. Particularly, all interview data, classroom observations and mediating artifacts were gathered under transcripts. Field notes consisted of the interpretation of the transcripts retrieved from interviews and observations. Specifically, the field notes included comments on the novice science teachers' instructional practices, their verbal and nonverbal communications occurring during the activity, as well as their interaction with other actors within their activity systems. In addition to the field notes, I kept a field journal to record personal narratives including my biases, feelings, ideas, and attitudes. Eventually, at the end of each data-gathering session, all field notes and transcripts and partly the filed journals were entered into a word-processing program for data analysis.

Methods of Data Analysis

Coffey and Atkinson (1996) described qualitative data analysis as the process of searching for general statements about relationships among categories of data. According to Guba & Lincoln (1989), in qualitative research, data collection and data analyses go on at the same time in order to promote the emergence of substantive understandings grounded in empirical data. Throughout the study, I analyzed my data soon after it was collected. In order to make sense of my data, the trajectories of CHAT guided my data analysis process. By this I mean that I specifically focused on themes and phenomena that emerge from each participant's activity system components, which include in-depth analysis of subject, object, mediating artifacts, rules, communities, division of labor and outcome.

Having richer data ensures valuable insights in the foundational elements of an activity, e.g., subject, object, tools, and community, and provided me a clear perspective on the whole activity system of beginning teachers. With respect to CHAT, I started the interpretation of the data with single events in each beginning teachers' activity system

and eventually consider the wholeness of the activity and the interactions that occur among the different elements.

Qualitative Data Analysis

Through data collection analysis, I was concerned with fleshing out a CHAT theory, a process that implies interpreting data. For that purpose CHAT provided me with a theoretical framework with prior categories to understand the activity systems of these teachers. For this research since the trajectories of CHAT as a theoretical framework precluded complete use of grounded theory, the prior categories of CHAT guided me to look outside the personal, but at the same time look to the data to see the various facets within each category. Within each prior category, I used Strauss and Corbin's (1998) grounded theory to connect related themes emerged from these categories. In many case studies, the emerging themes guide data collection process. However, the formal analysis and theory development do not occur until after data collection is near completion (Bogdan & Biklen, 1998). Meanings were constructed from the data collected in this research using a constant comparative method of analysis (Strauss & Corbin, 1998). The *constant comparative method* is a research design for multi-data sources in which formal analysis begins very early in the research and is nearly completed by the end of data collection. The approach uses a systematic set of data procedures to develop theories and concepts directly from detailed data collected around the phenomenon. Therefore the intent was not to prove determined theories, but rather to generate theory from the data and provide supporting evidence. In doing so, the constant comparative method of analysis aims to generate explanatory propositions, which correspond to the "reality" of the phenomenon under study.

The constant comparative method of analysis is complex and requires researcher to think analytically. Glaser (1978 as cited from Bogdan & Biklen, 1998, p. 65) indicates six steps of constant comparative method as follows:

1. Begin collecting data.
2. Look for key issues, recurrent events, or activities in the data that become categories of focus.

3. Collect data that provide many incidents of the categories of focus, with an eye to seeing the diversity of the dimensions under the categories.

4. Write about the categories you are exploring, attempting to describe and account for all the incidents you have in your data while continually searching for new incidents.

5. Work with data and emerging model to discover basic social process and relationships.

6. Engage in sampling, coding, and writing as the analysis focuses on the core categories.

Based upon these attributes, Strauss and Corbin (1998) increase the systematic and rigorous process of constant comparison method of analysis. Through moving from lower level concepts to higher-level theorizing, they suggest detailed theoretical comparisons-systematically and creatively- engage researchers in “raising questions and discovering properties and dimensions that might be in the data by increasing researcher sensitivity” (Strauss & Corbin, 1998, p. 67).

Given my qualitative approach to data analysis, I began analyzing the first observations, interviews, documents as well as open-ended questionnaires. According to Creswell (1994), in qualitative research, data analysis allows categorization, but the categorization should be carried out in a way that is open to emerging probabilities. Because of the multiple data sources, the data were exceedingly complex and not readily convertible into standard measurable objects. I analyzed all data according to Strauss and Corbin’s (1998) three stages of data analysis: (1) open coding; (2) axial coding; and (3) selective coding.

In open coding, a researcher reads through the filed notes and interview transcripts and assigns codes to each meaningful phenomenon, which is part of the field notes, transcripts, and documents that fall under a particular interest of the researcher (Bogdan & Biklen, 1998). As suggested by Emerson et al. (1995), during the stage of open coding, I sought to generate as many codes as possible without considering the strong relevance to primarily established focus of the research. Additionally, I described specific themes written from the observations, interviews, open-ended questionnaires as

well as all documents and artifacts through reflecting a variety of ideas and insights (Strauss & Corbin, 1998). These initial memos reflect on interpretations of data and become additional pieces of data and were employed in further analysis.

In axial coding, a researcher seeks for and documents emergent trends and patterns by using specific incidences from the data to support the interpretation (Strauss & Corbin, 1998). During the axial coding, I sought out patterns and trends in beginning science teachers' sense of self-efficacy beliefs and pedagogical discontentment as well as contextual influences on the changes in these novices' self-efficacy beliefs and pedagogical discontentment.

I employed selective coding after collecting all the data and initially interpreting them, as well as identifying the trends and themes. The process involved a careful scrutiny of the trends and themes and reexamination of all of the field notes, transcriptions, field journals and responses in an effort to accurately describe the phenomenon (Strauss & Corbin, 1998). In this stage, it was my goal to compare each beginning science teacher's activity system and identify and describe common themes among these three activity systems.

By utilizing these data analysis methods, I generated an in-depth understanding of change in beginning science teachers' sense of self-efficacy and pedagogical discontentment and also developed an understanding about the influential factors over these changes during their first year of teaching. I specifically performed the data coding process for each beginning science teacher's activity system, and then looked across these activity systems. By using these data analysis methods, I built explanatory arguments toward answering my research questions.

In utilizing these methods, a researcher should be open to the novel ideas that might emanate through the research. However, Smith (2002) indicates that it is inevitable that researchers come to the research setting with background knowledge and biases that influence the processes of data collection and analysis. Consequently, Bogdan and Biklen (1998) draw the image of a good researcher, and they argue, "good researchers are aware of their theoretical base and use it to help collect and analyze data" (p. 33). Additionally, they caution that researchers should be open to being shaped by the research experience and to having their thinking informed by the data. Given the mutually influential

relationship between research and researcher, before analyzing each beginning teacher's activity system, I had thoroughly laid out my theoretical background that may influence this research, thoroughly expecting that this same background was shaped and revised by the research process itself.

Based on my assessment of the available literature, I argue that research conducted based on a CHAT framework yields richer data, which provides more comprehensive results and a stronger "feeling" of understanding of the changes within the activity. The activity systems created for each educator in this case study presented a picture of how the individual beginning science teachers' sense of self-efficacies and pedagogical discontentment change over time and how those changes reveal themselves in the teaching practices of these novices. Such data also enabled me to compare and contrast the change across each beginning teacher participant in the study. In addition, as the change is dynamic, having measures of the multiple factors within the activity added the ability to identify most influential factors over the novice science teachers' sense of self-efficacy and pedagogical discontentment.

Eisner (1993) describes that qualitative research reports are descriptive, incorporating expressive language (Eisner, 1993). To achieve this in my research, where possible I worked to report the findings in the participants' own voices. I cited the interview quotes by a format that included the capital letter of the participants' initials, interview date and the page number from the original data (as in "N/09/15/05 P.13"). Additionally, the quotes from documents included the capital letter of the participants' initials, the description of the document and the page number, if it was applicable. The format for such quotations was "N/Teaching Philosophy OR Lesson Plan".

Quantitative Data Analysis

Within the quantitative approach, I analyzed the data collected through the STEBI-B and CBATS instruments in the form of descriptive statistics. In descriptive statistics, I looked for totals for each measure, and then document how these totals change during the research period. Then, going back and forth between these data and the qualitative observations, I generated an understanding of the change in beginning science teachers' sense of self-efficacy and the influential contextual factors affecting

these teachers' self-efficacy beliefs. And I displayed the analysis using the EXCEL program.

Within this study, one of the limitations of the quantitative data analysis was the sample size. Because I distributed these surveys only to two beginning science teachers, the study's sample size was not indeed appropriate for further statistical analysis beyond simple description. Another limitation of the quantitative data analysis was that the participants were not drawn through random selection. As I discussed earlier, I selected my participants through purposeful sampling. Because of purposeful sampling, my statistical findings were not generalizable to the whole first year beginning science teachers. Thus, these data played a secondary role in the research, supporting the qualitative findings. I do not report these data directly, but they were employed to triangulate the findings of the qualitative data.

Role of the Researcher and Assuring Rigor of Research

The nature of qualitative study requires a researcher to define his or her role in a study. In a qualitative research, researchers acquire multiple roles in order to develop research relationships with different people (Marshall & Rossman, 1989). Therefore, Marshall and Rossman (1989) argue that the researcher cannot simply be an observer who just gathers data. Moreover, researchers who conduct qualitative studies need to propose and develop roles, explain all the steps of the research to the participants and at every occasion, motivate participants' cooperation (Marshall & Rossman, 1989). These tasks require that the researcher act more on the participant side of the participant-observer continuum.

In case studies, and indeed, in all qualitative research, the researcher is the primary research instrument. When this is the case, validity and reliability concerns can arise. The human researcher may misinterpret or selectively attend to only certain comments. Guba and Lincoln (1989), as well as Merriam (1998) concede that this is a problem with case study work. However, this subjectivity of the researcher is also a strength of qualitative research, as the researcher's knowledge and background allow for inferences and explanations to be created to account for the data. Yin (2003) lists five attributes that a researcher must acquire to maximize meaning making and minimize

problems with validity and reliability associated with the use of the human research instrument.

1. A person should be able to ask good questions and to interpret the answers.
2. A person should be a good "listener" and should make every effort not be trapped by his or her own ideologies or preconceptions.
3. A person should be adaptive and flexible, so that newly encountered situations can be seen as opportunities, not threats.
4. A person must have a firm grasp of the issues being studied, whether this is a theoretical or policy orientation, even if in an exploratory mode. Such a grasp focuses the relevant events and information to be sought to manageable proportions.
5. A person should be unbiased by preconceived notions, including those derived from theory. Thus a person should be sensitive and responsive to contradictory evidence (Yin, 2003, p. 59).

Question Asking

Yin (2003) stated that case studies require an inquiring mind not only before and after the activity, that also during the activity. The ability to pose and ask good questions is therefore a prerequisite for a case study researcher. Becker (1998) illustrates the significance of asking good questions through rich dialog that encompasses:

...pondering the possibilities gained from deep familiarity with some aspect of the world, systematizing those ideas in relation to kinds of information one might gather, checking the ideas in the light of that information, dealing with the inevitable discrepancies between what was expected and what was found by rethinking the possibilities of getting more data, and so on. (p. 66)

According to Yin (2003), one insight into asking good questions is to understand that research is about questions and not necessarily about answers. As I collected my data, I continuously asked myself what would allow events to appear, asking a series of questions designed to reveal aspects of the participants' experiences and how they were experienced emotionally and cognitively.

My interpretations of participants' tentative answers led me to search for additional evidence, thus I carried on the conversation. To maintain a productive conversation, I conveyed follow up questions to my participants during the interviews. During the course of my transcription, I sometimes realized the necessity of asking additional follow up questions of my participants. In such events, I occasionally attempted to rearrange emerging issues interviews to bring up such questions and related issues.

Listening

Yin (2003) warns that for case studies "listening" does not solely mean receiving information through the aural modality. Therefore, to be a good listener depends on one's ability to facilitate multiple modalities. For example, this includes making eager observations or sensing what might be going on-not just using the aural modality. Being a good "listener" means being able to assimilate large amounts of new information without bias. Practically, Yin suggested that as an interviewee describes an event, a good listener hears the exact word used by the interviewee and captures the mood and affective components, as well as understands the context from which the interviewee perceives the world.

Given that being a good listener is a key characteristic of a researcher, I combined my listening skills with the document analysis and the observations of real-life situations. Through corroborating different sources of information, I worked to recognize possible important points that may have been said "between the lines" in conversations. Through listening closely during our conversations, I tried to not to smooth out difficult moments, and I simply waited through instances of hesitation and ambiguity. I waited as I valued these moments as a way of generating ideas. Although I developed proficient listening skills during the interviews and transcribing them, there existed incidents in which I was not sure about the details of conversations. In such moments I did not hesitate to ask for clarification to my participation to ensure the accuracy of the data.

Adaptiveness and Flexibility

Yin (2003) claimed that it is usual to observe major or minor changes in case studies. Thus, he envisions the skilled researcher as one who remembers the original

purpose of the study but is also willing to adapt procedures or plans if unanticipated events occur. Since this study required me to spend a vast amount of time with my participants in their first-year activity system, there were times in which my participants were not able to devote their time for this research. In those events, I rescheduled the meetings. Additionally, when something unplanned happened during the study, I was flexible and willing to adapt new procedures. Because of the extensive time I spent with my participants, I became their friend whom they spoke with about problems that they were not able to share with their colleagues. In some occasions, the participants needed to speak with me outside of our normal meeting times, particularly if they were struggling with something. I was always ready to listen to their thoughts and try empathizing their feelings. Thus, I assured to balance adaptiveness with methodological structure during the course of the research.

Grasp of the Issues Being Studied

The best way to stay on target is to understand the purpose of the case study investigation (Yin, 2003). Through my thorough review of the beginning science teacher literature, I understood many of the issues and accounts of my research foci. I was aware that without a firm understanding of the issues, I may have missed important clues.

Yin (2003) proposes that data collection in case study is not merely a matter of recording data in a mechanical way. A researcher should also be able to interpret the information as it is being collected. This seemed to be important especially when the sources of information contradict one another and result in the need for additional evidence through inferences. I gathered inferences based on evidence from different data sources including artifacts, observations, numerical instruments, as well as interviews. During the research, I occasionally revisited literature and seized ongoing issues in the research focusing on beginning science teachers' induction along with the data collection, analysis and discussions of the research. Because of the extensive time I spent in the activity systems' of these novice science teachers, revisiting literature was particularly helpful to me to keep up with the main issues of this research. In the discussion chapter of this research, findings of this research were tied back to and compared to the extant literature.

Recognizing and Bracketing Bias

According to Yin (2003), all of the attributions discussed here can be negated if a researcher seeks to use a case study only to substantiate a preconceived position. He indicates that case study researchers are prone to this problem since they must understand the issues ahead of time, and with this understanding comes bias. Therefore Yin (2003) suggested that the possible testing of bias is the degree to which a researcher is open to contrary findings. For example, a researcher studying “nonprofit” organizations may be surprised to find that many of these organizations have capitalistic and commercial motivation behind their works. In this research, any inconsistencies observed between the participants’ words and their actions may be possibly considered as a negative case. For example, the beginning teachers’ student-centered science teaching philosophies may consistently contradict their teacher-centered practices.

During the research, if I faced contradictory findings based on compelling evidences, I reflected on such findings at the conclusion of the case study report. Additionally, I observed a possible value of sharing my preliminary findings with my colleagues for their critical reflection, and I always sought to triangulate findings to gain a better sense of the data and how best to represent it. These actions were undertaken to search for alternative explanations of the data as well as identify the need for additional data collection activities. In cases where contradiction in data cannot be resolved, all supportable assertions were represented and discussed in the final text.

In this study I employed both quantitative and qualitative data collection methods. Creswell (1994) stated that using these methodologies within a research provides with a form of triangulation since the convergence of the two approaches ensures multiple methods of data collection and analysis on the same phenomenon.

Furthermore, the use of multiple sources of evidence in case studies allows a researcher to address a broader range of historical, attitudinal, and behavioral issues (Yin, 2003). On the other hand, Yin (2003) stated that the most crucial advantage presented by facilitating multiple sources of evidence is the development of *converging lines of inquiry*. Yin (2003) defines converging lines of inquiry as the use of several sources of information, following a corroboratory mode to ensure any findings or conclusion in a case study.

Additionally, the use of multiple data collection including both qualitative and quantitative methods such as surveys, questionnaires, interviews, participant observation, and the collection of mediating artifacts enhanced the validity of this study through the triangulation process.

On the other hand, Strauss and Corbin (1990) warn that a researcher might discover negative instances, or data might contradict previous developing patterns during the triangulation of data analysis. When it is the case, Gall et al. (1996) suggest that the researcher should ask participants to clarify the inconsistencies. Guba and Lincoln (1989) identified this process as “member checking.” The process of member checking has been recognized as one of the most crucial techniques for establishing credibility of the research (Guba & Lincoln, 1989). To fulfill the credibility criterion, I constantly checked my emerging understanding via conversations with the participants during and after data collection. In addition, I checked my reports’ accuracy and completeness by allowing them to read the cross case analysis and discussion of this research. Since the cross case analysis was a distillation of the entire study, I thought it was more appropriate for them to engage with this text rather than the entire voluminous document (this was particularly important in that they are both still practicing teachers attempting to wrap up their second year of teaching). Instances in which they differed with my analysis are reported in the final document. Both of my participants were aware that they had a full access to the transcripts of their own interviews as well as the full document. In one case, one of my participants wanted to read one of my observation transcripts from his classroom. Initially he thought that the class was one of the most effective classes that he was able to generate in his first year. However, after reading the transcript he realized that there were critical aspects of his teaching that he needed to address.

Another test for the quality of case studies is reliability. Yin (2003) indicates that the objective of testing the reliability is to be sure that if a later researcher followed the same procedures as described by an earlier researcher and conducted the same case study again, the latter researcher should have the same findings and conclusions. The goal of reliability appears to minimize the errors and biases in a study. To ensure the reliability of the research, Yin (2003) suggest that “[T]he general way of approaching the reliability problem is to make as many steps as operational as possible and to conduct research as if

someone were always looking over your shoulder” (p. 38). As discussed earlier, during the research I asked my major professor to review the transcripts of all data analysis and met with her periodically to discuss emerging themes and interpretations. Since the participants of this research were the students of my major professor during their preservice years and because she had worked within both school settings, she gave useful feedback in terms of my tentative assertions.

In addition to ensuring the validity of the study, I was concerned with whether the understandings generated from each of the beginning teacher’s activity system might inform general thinking about a study to similar settings. Although some researchers find the generalizability of case study findings to other cases problematic (e.g. Gall et al., 1996), some suggest that generalizability is one of the strengths of the case studies; that is, the findings are transferable to similar settings (e.g., McApine & Crago, 1995). McApine and Crago (1995) argued that case studies on beginning teachers have common results even when they are conducted in different countries with different educational systems and culture. It seemed that problems embedded in the change in beginning science teachers during their induction period were universal. I was also concerned with whether the understanding generated from each beginning science teacher’s activity system might inform the general thinking about the most influential factors in these changes. Guba and Lincoln (1989) defined generalizability or transferability as the applicability of the findings of a study. Research findings in induction of beginning teachers might be similar for many beginning teachers; however, case studies strictly highlight the individuals’ own experiences as the central aspect of the research studies (Merriam, 1998). Consequently, Strauss and Corbin (1990) proposed that developing descriptions and interpretations that are “faithful to the everyday reality” of a phenomenon and that are based on broad interpretations should “make it applicable to a variety of contexts” (p. 57).

All in all, through consideration of the criteria of credibility, validity and reliability and applying related methods of these criteria, and by conducting my research mindful of Yin’s (2003) five attributes for a researcher doing a case study research, I ensured the quality of this research project.

Researcher

Given the role of a researcher's subjectivities in the qualitative analysis process, it is important to know my subjectivities in terms of this research. I was born and raised in Turkey, a country located in the intersection (both geographically and ideologically) of the Middle East and Europe.

In 1997, I received my Bachelor's degree in Science Education in Turkey from Gazi University, a well-known institution with an excellent reputation for its preparation of successful teachers. After receiving my degree, I became a science teacher and worked for a year as a middle school science teacher in a rural area located in the middle part of Turkey. Indeed, the experiences that I gained during my first year of teaching were the foundation of my current education. During my first year of teaching I was simultaneously seeking my masters' degree in science. After one year of teaching, I moved to Ankara, the capital city of Turkey and started teaching elementary and high school science classes in a private school. I also tutored different science subjects during my year of private school teaching experience. Later on, I decided to focus on my academic studies and temporarily quit teaching. As soon as I entered the academia, I found myself teaching different science subjects including general chemistry, general biology, and physics and associated subjects in laboratories for undergraduate science teacher education at Gazi University.

While pursuing my academic goals as a master's student, I was qualified to pursue graduate studies abroad under the sponsorship of Turkish National Ministry of Education. I decided to halt my current studies and leave my country in order to pursue my Ph.D. degree in science education. For this, I came to the United States in 2001. I first started my graduate studies at the University of Missouri at Columbia. After eight months I transferred to the Science Education program at Florida State University to continue my academic studies. In December 2002, I received my master's in science education. For my masters' degree thesis, which was also a qualitative research, I studied a college professor's efforts to transform a traditional general chemistry teaching approach into a more student-centered one. During my study for the masters' thesis, I gained a great deal of knowledge about qualitative research and also partly fulfilled one of my goals: to explore students' motivation toward science learning at the college level.

After successfully defending my masters' thesis, I started my Ph.D course work in the same program. My current goal is to receive my Ph.D degree through an in-depth study of the process of science teacher development.

Indeed, my experiences in science education have shaped my current research interest. Being one of the future science educators in Turkey, I urgently want to find ways to support and improve the Turkish educational system. Recently, similar to the US, the Turkish educational system has been under the influence of reform movements, especially in science education. Educational researchers and policy makers have become more interested in student-centered science education. The current interest in student centered teaching and learning has influenced both teacher education system and curriculum studies in science education. Traditionally, in Turkey, science teacher education institutions provide a great deal of science content knowledge. The pedagogical content knowledge was limited by the general pedagogical content knowledge including educational psychology, educational sociology, and special educational methods. However, within the nationwide reform movements, now the Colleges of Education in Turkey have changed their curriculum to educate reform-minded science teachers through various types of science teaching methods courses. In spite of the current influence, the reform efforts have been failing because of the lack of research supporting the reform recommendations in science education.

Unlike in the US, teaching is one of the most popular jobs in Turkey. Despite the low salary and low respect for the teaching profession, the job security found within this profession in Turkey compels high school graduates to join the education faculty. Additionally, because of the current popularity of the teaching profession, teacher retention seems not to be an issue in Turkey. On the other hand, the lack of reform-minded teacher educators and the lack of support for teachers to enact reform-based practices are significant problems for Turkish Educational system.

Therefore, during my preparation for my doctoral preliminary examination, I came to understand that to achieve a systemic change in education especially in science education, there are two important issues highlighted in the teacher education literature. One of them is the need to create teacher education institutions to educate reform-minded teachers who are well prepared in terms of their pedagogical and content knowledge.

Another important aspect is to support these reform-minded beginning teachers toward implementing reform-based practices. Therefore, in order to support Turkey's reform efforts in science education, I understand that I have a valuable opportunity to benefit from the US's experiences in educational reform. By exploring the US's extensive experience, I might support the Turkish educational system in its desire to have a systemic change in science education.

Additionally, being an international researcher, I understand the differences between my original culture and the existing culture that I live in now as well as the difference in the context that I interact with. I believe that my position as a bi-cultural researcher gives me a unique understanding as well as opportunities to compare the two cultures. I believe that this difference had some beneficial influences on my interpretations of the different aspects of this research by viewing things through two cultural lenses. Also being a non-native English speaker might influence my communication in the research site. I tried to pay more attention to my communication with participants and clarify any misunderstandings if possible immediately, or through later member checks, in order to minimize any misinterpretation of my research data.

Throughout this descriptive study, I specifically focused on understanding the change in reform-minded beginning teachers during their induction period. It was also my goal to explore the most influential factors over such changes during beginning science teachers' induction period. It is clear that the proximal goal of this study is to understand the activity systems of the beginning science teachers. However, that may have the eventual goal of designing programs to better aid novices (in Turkey, in the US, and indeed, in the global science education community) to operate within these programs.

Research Ethic

In terms of quality of the research, I paid attention to Goodson and Mangan's (1991) views on epistemological and ethical implications in qualitative research. According to Marshall and Rossman (1989), efficiency and ethical considerations are the most significant quality criteria for a qualitative research. Given that the ethical consideration and confidentiality, I did not solely consider ethical matters as one-time issues. According to Clandinin and Connelly (2000), receiving the Human Subject

Committee's approval to proceed with research was only one of many safeguards to ensure the ethical soundness of a study. Therefore, to ensure ethical constraints were respected during the study, I followed Bogdan and Biklen's (1998) four principles on ethical issues:

1. Unless otherwise agreed to, the subjects' identities should be protected so that the information you collect does not embarrass them.... The researcher should not relate specific information about individuals to others and should be particularly watchful of sharing information with people at the research site who could choose to use the information in political or personal ways.

Since the participants of this research were the graduates of the program that I was involved with as a graduate student, I paid special attention to protect the identities of these particular novice teachers within the program. I used pseudonyms for my participants starting from the early days of this research.

2. Treat subjects with respect and seek their cooperation in the research. Under usual circumstances the subject should be told of your research interests and should give you permission to proceed. Get written consent. Researchers should never lie to subjects or record conversations on hidden mechanical devices.

Receiving Human Subject Committee's approval to proceed with research was one of the safeguards to ensure the ethical soundness of this research (See Appendix E). I also received approval from the County's School (See Appendix E) to access the activity systems of each participant. Besides the County's approval, I also received the approval of each teacher's administration to enter the activity system of these novices. It was also another facet of ensuring the ethical soundness of this research. I also informed my participants about the research and received from them their consent before starting the research. By seeking approval for this research, at each level I was asked questions regarding to the ethics and purposes of this research.

3. In negotiating permission to do a study, you should make it clear to those with whom you negotiate what the terms of the agreement are, and you should abide by that contract.... Because researchers take the promises

they make seriously, you must be careful ...to be realistic in such negotiation.

Since I personally knew these teachers from their preservice years, I started this research with a certain level of confidence generated by the trust between the participants and me. It was because of this comfort level, my participants openly asked me about the procedures of the research.

4. Tell the truth when you write up and report your findings... The most important trademark of a researcher should be his or her devotion to reporting what the data reveal. (1998, pp. 44-45).

As far as reporting the data and ensuring the accuracy and truthfulness of findings, I faithfully presented data and paid intense attention to the issue of confidentiality. Although my primary role as a researcher was to understand my participants' first- year experiences, I realized that my presence also served to shape these events. On several occasions, because of my continual presence in the activity systems of these novice teachers, I was the first to notice critical incidents in these teachers' classrooms. Because as a researcher my responsibility was to describe such events and work to understand my participants' interpretations of them, I understood that reporting such events to my participants was within my responsibilities as a researcher.

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 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. Although the participant believed that I played a critical role in helping him to stay in teaching by listening to him (N 5/07/07, email), it is important to note that he did not use the information or strategies that I offered.

Thus, this study posed particular ethical dilemmas, one's I resolved by erring in favor of supporting these novice teachers.

CHAPTER 4

THE CASE OF AN IDEALIST IN A DIFFICULT SETTING: NATHAN

The purpose of this chapter is to provide a detailed examination of the *subject* in Nathan's activity system; thus in this chapter I will explore Nathan's personal beliefs, his preservice pedagogical discontentment as well as his self-efficacy beliefs during the course of his first-year teaching and the way these constructs interacted to shape his enactment of science education reform. To better ascertain the patterns of changes in these constructs, in this chapter I will describe Nathan's beliefs, teaching self-efficacy and pedagogical discontentment before he started his first year, during the first year in teaching and at the end of his first year. This chapter will be followed by a more complete exploration of the subject of this activity system in Chapter 5.

The following description is a culmination of the data that describes Nathan:

Nathan seemed to be force of nature. In almost every situation I observed him in, and there were many (undergraduate classes, seminars, graduate classes, long talks at coffee, gabbing with grad students between classes), Nathan was always animated: pacing back and forth, moving his hands, smacking his forehead with his hand to make a point. He was always engaged, and even as an undergraduate he took course discussion very seriously. He was funny, always using humor to couch his ideas, poking fun at himself and others. Finally, he was always close to the "center of action"--meaning that wherever the focus of attention, Nathan was close to it. He always was a focal participant in class discussion. He always had questions of seminar speakers, even when undergraduates seldom raised their voices in questions. I cannot remember him being in the back of a room, acting

as a quiet observer, looking on as others worked. Instead, he was involved, engaged, and seemingly ready for anything that came his way.

Smith (2005) suggests that much of our approach to the teaching of science is shaped by our earliest experiences both with science and with learning. Thus, it is important to understand “where” a teacher comes from. The following section describes the personal life history of Nathan including his teacher education experiences.

In 2003 my major professor invited some the graduate students to participate in one of these methods courses. I first met with Nathan in this methods course as he was one of the undergraduate students. He was very talkative and always had something to say about the issues that came out during the semester. At that point, Nathan was an energetic, ambitious president of a major national science teaching organization’s student chapter. In addition to his regular preservice learning, Nathan participated in this organization’s student chapter throughout his college years. Through this organization, Nathan had many opportunities to meet with well-known science educators and these experiences broadened his view about teaching and learning science.

At the time of this study, Nathan was 24 years old. White, from the northeast section of the US, Nathan’s “Yankee” interaction patterns made him stand out in this southern town. Nathan was talkative, funny, outspoken, and eager to speak with anyone about anything it seemed. Part of what distinguished him from other undergraduates was his willingness to offer honest, sometimes biting, comments in response to others (something seldom seen in the South). His dual major in social studies reflected his intense interest in national and state politics, and his democratic leanings bubbled up in virtually all his conversations. Nathan was also an ardent, knowledgeable professional football fan with memories of almost all football teams and their players since back in his high school years.

Nathan’s Family Life and Early Childhood

Nathan was raised in a middle class family and he spent his childhood in a neighborhood right outside of Washington DC. His parents and one of his grandparents were college graduates, so his pursuit of an advanced degree is not surprising. School

and education were important to his family, and at the time of this study he continued to have long, substantive discussions with his mother about teaching.

Science figured into his childhood largely through family trips. During his childhood, the first exposures to science that he recalls were his visits to San Diego National Zoo, which, characteristically emphatic, he described as the “best zoo in USA”.

The next formal exposure to science that he remembered was his visit with his parents to a science museum in Ohio. He still thinks of the time that he spent at the science museum as remarkable. Similar to many other children at that time, it was also Nathan’s dream to be an astronaut until the Challenger tragedy brought to his attention the very real consequences of this choice. Then he changed his mind and decided to be a paleontologist because of his interest in dinosaurs. It is notable that his interest in both these areas remained with him, as astronomy was still a discipline that he gravitated to, both as a learner and as a teacher. Interest in biological evolution and speciation remained strong, and one of his first lessons he taught in a methods course targeted dinosaur extinction. Nathan was a learner with strong passions that had remarkable resiliency.

Besides these trips, Nathan’s growing interest in science was nurtured through television. When talking about his favorite childhood TV programs, his excitement was obvious. He explained:

I loved Newton’s Apple, which was a science show for kids. And I loved Mr. Wizard. I still remember episodes of Mr. Wizard. I remember one word he was talking about infrared light, and then we had like visible light.... I was like five or six. (N9/17/05 P. 3)

Although the opportunities his family provided for him to engage in science were memorable (as was the popular media), this was not the case for this primary education. Nathan’s memories of learning science in early period of his primary school years were few, although, for the most part, positive. Although he recalled participating in some science activities during his kindergarten and early elementary years, this memorable experiences waned as the years continued. This waning pattern continued as Nathan progressed in school, and he noted that he did not enjoy learning science during his

middle school years: “I remember in 7th grade we dissected frog and I was like whatever... It was disgusting” (N9/17/05 P.3).

This pattern began to reverse itself when Nathan entered high school where he began to enjoy in-school science. He targeted much of this reversal to the results of a two-week unit on relativity in 11th grade physics. He was very deeply inspired by that unit and the unit captured his interest in physics.

And I looked at one of the equations, it was Einstein's' equations for time T prime, which is the change in time equals t which is the experienced by stationary observer times the square root of $1 - v^2/c^2$. And what we find is that if you go to speed of light, v^2 , in fact, and your Δ goes to the infinity. Or sorry, this should be divided by t . When you plug the value for c , which is the speed of light, and for v you get an undefined equation. ΔT should go to infinity. And I asked my science teacher, physics teacher about that she had no answer. She couldn't sufficiently answer me. So I needed to find out more. And I read that equation right there is the single reason I am a physics teacher today. (N9/17/05 P.3)

Nathan later pointed out that the subject was not the sole reason for him to be interested in physics. His physics teacher was also a major factor in shaping Nathan's love of physics. Although her teaching style was essentially lecture-oriented, she managed to inspire her students; she helped foster their interest in physics and other science. He explained:

Well I don't necessarily agree now with some of her teaching methods. With that respect not a lot of inquiry, not a lot of some of the things we hope to see. You know, she got me in physics. So she did the job...And I know from four years I was in high school. For four years she had four sets of students one student from each year ended up being a physics teacher. I know, 'because I e-mailed her. She said “well it is fun you know, you're not the only one.” And I knew two of the other students. One of them I didn't know. (N9/17/05 PP.3-4)

Nathan believed that his physics teacher was exceptional because of her knowledge and her ability to “deliver” content knowledge to her students. This particular teacher is notable, and as we focus on Nathan's own teaching, we'll see the shadow of her work.

She was good! I mean, you knew the physics whether you got the inquiry. Some of the students may not have been able to translate the equations into real world situations, but you knew physics. I mean you knew those equations. (N9/17/05 PP.3-4)

However his positive feelings toward his physics teacher and physics, Nathan did not like other science subjects in his high school years. His 10th grade chemistry learning experiences especially influenced his ideas negatively toward science and schooling in a broader sense.

I didn't like some of my science teachers. I still have great animosity toward my 10th grade chemistry teacher. I don't like her. Just, you know if I am taking notes in the class, I should take notes so I know what I am talking about not so she can read them and know that I know what I am talking about. And some of those experiences, this is 10th grade shaped my science. (N9/17/05/P.4)

The combination of his chemistry teacher and physics teacher helped Nathan realize that a teacher can be a huge influence over students not just in terms of content learning, but also in terms of their beliefs about school and themselves. During the 10th grade Nathan decided to be a teacher in order to make difference in students' lives.

Well, I had known since I was in 10th grade that I wanted to be a teacher. I liked helping people learn, I liked being around learning, I liked being around people and I liked working with kids. So I have known for long time that I wanted to be a teacher (N9/17/05/ P.4)

Obviously, Nathan's lived experiences as a science learner inside of school and outside shaped his beliefs about what science is, what it means to learn science and what practices are involved in effective science teaching. He brought these beliefs and knowledge into this teacher preparation program, and in the next section I will analyze how this beliefs and knowledge were further shaped and served to shape Nathan's teacher education experiences.

Teacher Education and Preservice Experiences

As described by both of his methods instructors, Nathan was one of the most promising graduates from the program in the last several years. This judgment was based

upon his knowledge, engagement, criticalness and effort that he carried with him throughout his program. In addition to his undergraduate degree, after his graduation Nathan decided to pursue his master's degree in science education at the same university.

As an extension of his personal history, Nathan's preservice teacher education experiences also influenced what he believed to be effective science teaching. In particular, the program served to reinforce his fundamental beliefs that stem from his early field experiences with science teaching.

Nathan entered college with the intention of having a bachelor's degree in social studies education because of his interest in history. Instead, he realized that he would be able to find a job easily if he were a science teacher rather than a social studies teacher, leading him to pursue a degree in science education.

And throughout high school, in my first year here at college, I planned on being a social studies teacher. But I realize that it is much easier to find a job teaching science than to find a job to teaching social studies. Because you've got a degree in science, there is a lot of money; there [are] a lot of jobs. (N9/17/05 PP. 4-5)

Notwithstanding his major in science education, he was always interested in history particularly history of science and he planned pursue a graduate degree in social studies or educational leadership after his bachelor's degree.

So I thought maybe I double major. I will get an undergraduate degree in science education, and then get my master's degree in education or in social studies education right away. And then start teaching as a social studies teacher knowing that I had that background in physics that if I had to teach physics I could. So I winded up in science education as an undergraduate. The more I took, the more courses, the more I read, learned, the more I worked in the classroom the more I became a science teacher first. And now, I am a science teacher who's got an interest in history. Not a history teacher, he's got an interest in physics. (N9/17/05 PP.4-5)

Unlike his previous experiences in learning about science, the preservice learning period provided him with structured and purposeful experiences designed to influence his beliefs about teaching and learning. However, Nathan described that because he is an

“individual learner” who did not need a group to make sense, he didn’t see the value of much of these methods courses until he started his student teaching (N/9/17 P.5). He explained that his view of his own learning blocked his receptiveness to pedagogical content knowledge that he was offered during his methods courses.

We preach inquiry in science education because we know the learning is more authentic, more meaningful and more lasting. If the student experiences that for themselves than if I just sit there and lecture on the board and tell them that that is how it is. Same thing in science education that you don’t realize lecturing every day all day is not the best way until you get out there, and realize ‘You know what this isn’t the best way, I need to do something about it.’ (N/9/17/05 P.5)

Nathan understood the main emphasis of his preservice years was on reform and student-centered science instruction. He believed that he was well equipped with a variety of necessary tools for reform-based science instruction as he completed this program.

According to Nathan, the methods courses had “pretty much of a mixture” of both practical aspects and theoretical underpinnings in science teaching in terms of the way that his professors taught them (N/9/17/05 P.6). On the other hand, he recalled that many of them were designed to engage students in discussion and lead them to come to their own conclusions. He explained that his science education professors did not focus on the correct answer; rather they were interested in the students’ own understanding and their thinking process. Nathan understood his beliefs about effective science teaching and learning to be challenged by the program, and particularly in the methods course. He described that the program “made them question whether your previous beliefs, ideas about how to be an effective science teacher weren’t the best ways of being an effective science teacher” (N/9/17/05 P.6).

Each of the three methods courses had a field component, and Nathan had mixed reactions to these field experiences. According to his perception, each individual student had his/her own needs and he “didn’t need to watch a teacher teach for three hours a week for ten weeks” (N/9/17/05 P.7). Rather he sought opportunities not to observe, but to practice what he was learning in methods courses.

The opportunities in which he was allowed to teach had a great impact on Nathan and shaped his teaching philosophy. He indicated that these teaching practices enhanced

his self awareness about his particular teaching style, and they helped him to realize “things I didn’t notice about myself” (N/9/17/05 P.7). He recognized as well that “it was nice to have a teacher” to advise him about his particular behaviors that might distract students’ attention.

I make a lot of motions with my hands. And now when I am teaching I always have like a yard stick in my hand that I am playing around with. And I realized that that probably gets distracting for my students. They probably start watching what I am moving about as opposed to listening to the words that are coming out off my mouth.” (N/9/17/05 P.7)

Despite the importance of field practices in preservice period, he had limited opportunities to teach science lessons. During his methods courses, Nathan remembered teaching only four classes out in the public schools (although his methods instructors countered that he taught a minimum of 8), so he entered his practicum still lacking a wealth of personal teaching experience.

Student Teaching

Nathan student taught at the same school in which he eventually found his first teaching post. This student teaching experience provided him with practical skills and broadened his visualization of science teaching. Only after he was engaged in student teaching did Nathan realize the influence this methods courses had on his teaching practices. Nathan noted “You come into teaching in the teacher education program with these ideas of yourself as a teacher. You’re not really presented about why those ideas might not be the best ideas until get out there for yourself” (N/9/17/05 P.5). However, Nathan indicated that he cherished his undergraduate methods courses, which provided him different tools and approaches. But he realized “[methods courses] were effective, but they were effective much more after the fact than immediately” (N/9/17/05 P.5).

During his student teaching period, he strengthened his teaching skills and abilities in many ways and his cooperating teacher was very helpful and gave him “a lot of freedom” to teach in her perfect classroom environment (N/9/17/05 P.7). It was perfect for Nathan as a student teacher to teach lessons given the “tight” management of the classroom provided by the cooperating teacher. And he noted that despite his distaste for

the purposeful quietness in his cooperating teacher's classroom, he learned many management techniques from her.

Another thing Nathan learned from this cooperating teacher was the effectiveness of immediate feedback. He found out that if his cooperating teacher assigned something to her students, she evaluated their papers within two days, allowing the students to benefit from her feedback. Moreover, Nathan's cooperating teacher was very organized, and through observing her, Nathan recognized the importance of organization for effective teaching.

Although his cooperating teacher was very helpful and supportive, Nathan "didn't necessarily like the way she was doing things" (N/9/17/05 P.7). Soon after he started his student teaching in her class, Nathan realized a mismatch between her teaching style and his ideal teaching style. His cooperating teacher's teaching style was teacher centered and book-oriented, whereas he believed that the most effective way of teaching science was student-centered and inquiry-based approach. Therefore, rather than imitating his cooperating teacher's teaching style, Nathan tried to focus on the development of his own teaching style within this almost silent classroom.

Nathan's Selection of Kent High School

Nathan's own academic performance during his high school years was lackluster, but his family thought of him as a capable student placed in a school that didn't "provide challenging enough or intellectually stimulating enough material" for him. During this time, Nathan came to understand that teachers make decisions on behalf of their students by channeling them to specific courses (N/03/01/06 P.2). In his own high school career, he was on the positive end of this relationship, and his own teachers pushed Nathan to go to college, and they inspired him to become a teacher.

Recognizing the potential power of teaching during his preservice preparation, Nathan decided that he wanted to teach a group of kids who shared his own high school orientation--he wanted to teach students who needed support and for whom his efforts could be transformative. Because of this, Nathan selected Kent High School for his first year as a professional, as he thought that he could make "more of a difference at Kent

High School.” For Nathan, making a “difference” would entail preparing at least three of four students to “deal with the world” (N/03/01/06 P.3).

General Context of Kent High School

Kent High School was one of the six 9-12 comprehensive public high schools in the Southeastern school district. The district where the Kent High School was located is a “school choice” district meaning that students in this county can attend the school for which they are districted or can attend other available schools. At the time of this study, the district had a racial composition of 66% white, 29% African American, 4% Hispanic, 2% Multiracial, and 3% Other.

Kent High School was founded in 1960 and had 1239 students enrolled for the 2005-06 school year. The racial distribution of the school population consisted of 41 % Caucasian, 52% black, and 7% classified as other. According to the state statistics, 57% of the total student population at Kent High School was recognized as minority. During 2005-06 school year, 41% of student population was in the free and reduced lunch range. Compared to district level student percentile, the Kent High School had higher percentage of the student population living under poverty level.

The instructional staff consisted of 65 regular education classroom teachers, nine Exceptional Student Education teachers, one English as a second language teacher, one Reading Coach and 1 Media Specialist. If all these instructional staff were averaged in, the student to teacher ratio was 21:1, although more students were typically found in any one class. Among the instructional staff, six were National Board Certified Teachers. There was a very low teacher turnover for a bulk of the instructional staff; over 73% of the teachers working at Kent High School had more than 10 years experience, and 50% of those teachers spent a minimum of 10 years at Kent. Over the last few years, the school was known for “losing” its new science teachers. Before Nathan, the science department lost six science teachers after their first year of teaching at Kent High School.

The administration of Kent High School promoted teacher collaboration through a common planning time in the afternoons, allowing the departments to meet in groups, as well as allowing for Whole Faculty Study Groups, Reading/Writing Teams, or other need-driven teams as needed. However, a strong commitment to build up and maintain

the sense of collaboration among the teachers in different departments was not apparent. The level of collaboration was solely limited within specific departments.

The demographics of the school in comparison to the rest of the county and the longevity of the teachers could paint a misleading portrait of this school. In terms of student achievement, Kent High School received a grade of “D” for three years in a row between 2003 and 2006 in state achievement test administration, by far the lowest school “grade” for any of the 6 high school in the district. Part of the reason for this lackluster performance may be found in the schools from which Kent received its students. Kent’s “feeder” schools were also considered to be “low achieving schools” and have the similar achievement scores at the state achievement test. Because of the school’s continuing underachievement in the statewide standardized test, the school district mandated the school administration to prepare an improvement plan, which aimed to help the school administration to realize the ineffective facets of the school and seek for alternatives to improve school achievement. On the other hand, the report only highlighted monetary contradictions that the school faced to apply the improvement plans. The rest of the document was devoted to reporting the current situation of the school and the school administration’s improvement plans specific to improvement on the achievement test.

In the face of this history of low performance, Kent High School had undertaken some steps to improve. Kent was the only high school in the county to offer a block schedule, a choice that was made based on the hope that longer periods of time might allow students to better understand the material presented. It was the ESOL Center for the entire county. Because of Kent High School’s proximity to the local college and universities Kent High School also offered alternative dual-enrollment opportunities for students. Because of the close partnerships with the business community, Kent High School structured programs like Culinary Arts, Automotive Tech, Hospital, and Construction to meet the local society’s immediate work force. Although this was documented in school’s improvement plan, the application of this collaboration was limited by the few occupational courses provided by the school administration.

In terms of community relationships, Kent High School structured their communication with parents through school website and parent listserv. In addition, four times a year Kent High School published a parent newsletter. For special events, Kent

High School administration called parents individually to remind them of upcoming events prior to activities. Despite the school administration's attempt to create a sense of collaboration between the school and the parents, it was apparent that the parent involvement somehow did not exist. For instance, at the beginning of Nathan's induction school year, the school organized a 'back to school night', but only three parents attended the event. Whether this poor showing was due to the schools missteps in inviting parents or the parents' unwillingness to attend was the subject of some debate. In either case, there was not a strong link between the school and the families of students.

In the improvement report, the school administration described that much of the collaboration among teachers and the parents and the school were reflected in the schools vision statement, in which the administrators and teachers of Kent High School "believes that all students can be prepared for personal and professional success in the world of the Twenty-First Century" and understands that it is the high school's responsibility prepare its students to become respectful, successful, and productive citizens of the Twenty-First Century through a united effort of parents, students, teachers, administrators, and all community partners." Although these were promising goals, as Nathan was to find, the reality of the classroom was a much different place.

The school administrators' decision making and their emphasis on the school's improvement on the state accountability requirements created a tension between the administrators and the teachers. The science department teachers were critical about the administrators' emphasis on the students' math and reading scores, contradicted by their reluctance to improve science department via structural changes (such as materials and needed equipment). The chair of science department indicated that the school administrators were "not eligible for this job at all"--indicating his lack of trust in the administration of the school as a whole. Indeed, during my year at Kent I failed to see the principal at all. My persistent requests for an interview were not met with any sort of response (written or otherwise).

Not only the school principal, the vice-principals of Kent High School were also criticized by teachers because of their lack of high school teaching backgrounds and because their disciplinary decisions often seemed to be made divorced from the realities of the Kent High School context. However, much of this nuance was lost on Nathan

during this internship, and during which time he believed that the entire school was dedicated to helping students from socio-economically disadvantaged families. At the end of this student teaching, Nathan believed that his strong background in science teaching and his personal goals to help such students would allow him to make a positive contribution to the society.

Nathan's Initial Beliefs and Teaching Goals

Understanding the nature of teachers' beliefs is important if one is to understand teachers' practices (Smith, 2005). This section is an attempt to understand the main beliefs that Nathan held and how these beliefs changed during the course of his induction year. **Table 4-1** describes these early beliefs as well as their change over the school year. The emphasis of this section is to focus on Nathan's beliefs about teaching and learning as he entered his induction experience. It will be possible to track visible changes in Nathan's beliefs about teaching and learning as he moved through this induction year.

Table 4.1: Changes in Nathan's science teaching beliefs and practices during his induction year.

	Preservice	During First Year	End of the Year
Identity	-Competent -Student-Focused -Reform-Minded	-Self-Sufficient -Friend to students -Close to Learn	-Competent -Self-Sufficient -Partially Open to Learn
Beliefs about Teaching Science	-Reform -Impact -High Standards	-Pedagogy of Poverty -Survival	-Questions about reform in science and purpose of teaching in general
Personal Self-Efficacy	High	Low	High
Outcome Expectancy	High	Low	Low
Pedagogical Discontentment	None	N/A	N/A
Classroom Management	Limited	Severe	Agenda for Classroom Management
Assessment	N/A	Traditional	Traditional Student Journals
Teaching Artifacts	N/A	Textbook	Textbook
Emotional Energy Generated	Profound	Low	Low

Table 4.1: Continued

Overall Practice	Preservice	During First Year	End of the Year
	Reform-Based	Didactic	Lecture
	Inquiry	Lecture	Didactic
	Enacting Science	State Curriculum	State Curriculum
	Education Reform		
Object	Change Agent/ Inspire	Inspire Student/	Hope for an effective year
	Students	Survive	
Teaching as a Profession	Second Choice	Considering to leave the	Move to another school
		profession	Limited years of teaching
		Pursuing another career	

An investigation of Nathan’s beliefs illustrated that a significant portion of Nathan’s beliefs about teaching and learning science were based on his own science learning experiences. He noted that he “hated science” during his middle school years because of the way it was taught by teachers who were “killer” (N/9/17 P.9). He described that the way he was taught science as very traditional and teacher centered. He specified this experience as “...talk about this for half an hour, here is your homework, do some problems. That is not science and that is not what science should be.” (N/9/17 P.9)

Nathan’s Initial Beliefs about Science

Nathan understood science as an inherently creative process: “The science comes in the finding the answers of questions” and “the creativity comes in the asking of the questions” (N/9/15/05 P.14). Nathan believed it was his responsibility to highlight creativity in science classrooms, in part through exposing students to current “exotic theories,” which he understood to be the direct result of scientific “creativity.” (N/9/15/05 P.14). However, as opposed to today’s science, Nathan posed that traditional science in our schools fosters a culture where “students are not required to ask questions,” and so there he saw little hope for students to think creatively (N/9/15/05 P.14). He indicated that it was because of the opportunity for him to ask questions in his science classes that he became a science teacher. Thus, while his beliefs about teaching and learning described a need for specific teaching methods, this specificity was in contrast with his conception of a much more open, creative nature of how science itself is done.

Throughout our discussions, his emphasis on the prominent role of evidence, questioning, recognition and many methods of science, while recognizing the need for teacher support of student learning, remained strong.

Nathan's beliefs about the nature of science were heavily influenced by his graduate studies. After his graduation from the science education program he enrolled in Philosophy of Science class and this course influenced his beliefs about what science is and how it operates. As opposed to the beliefs that Nathan held during much of his preservice era, after this graduate course, Nathan entered his first year understanding that "Science is not very easily defined" (N/9/15/05 P.1). To better understand the definition of science, it is necessary to define Nature of Science first. Thus, he noted:

...the NOS, it is inquiry and it is asking questions, and it is a methodological approach to answering those questions. It doesn't imply that there is a one approach to answering all questions. But it systematically got looking for answers, and it is naturalistic. NOS assume that there is natural explanation for all observed phenomenon. (N/9/15/05 P.1)

Additionally, he understood the methodological naturalism of science as a central aspect of its nature, explaining that science does not reject the existence of God and "the only claim it makes about God is [that] science has no ability [to] make claims about existence of God" (N/9/15/05 P.1). It was evident that his notion of the science and religion relationship became visceral aspect of his NOS knowledge during his early classroom teaching, as he explained "In this evolution and intelligent design [discussion], I want my students to realize that you can be an evolutionist and believe in God at the same time" (N/9/15/05 P.1). He referred to this approach as a "middle way," stressing that "intelligent design should not be in science curriculum because intelligent design and evolution are mutually exclusive." Nathan indicated that at the level of science, "we can't talk about God" as science is methodologically naturalistic (N/9/15/05 P.2). And in his own classroom, he perceived that he needed to explain to students "how science doesn't necessarily have all the answers, [it doesn't suggest] that there is no supreme being." (N/9/15/05 P.2). Nathan also understood that there is no one single "true" answer for any question available through science, explaining that science is always open to re-interpretation and investigation.

Nathan's Initial Beliefs about Science Education Reform

Although Nathan's sophisticated understanding of the nature of science surfaced again and again in his discussions of teaching, the process aspect of science learning did not overshadow his perception of the need for teachers to emphasize students' conceptual understandings. He understood that it was the role of teachers to provide students with discussion opportunities to support their constructions of conceptual understanding. Because of this belief, Nathan criticized the overwhelming emphasis on traditional homework. Based on his middle school and high school experiences, he thought that through traditional assessment techniques, science teachers often "disservice their students" by guiding them to "homework completion" instead of conceptual understanding (N/9/15/05 P.14).

Nathan struggled to make sense of the result of his application of his robust understanding of science in the classroom. He saw that students refused to believe that "they're right until they're told they're right" and found it difficult to accept the responsibility for their learning (N/9/15/05 P.10). Nathan explained that when a teacher stresses that there is no right or wrong answer for an activity "[students] don't like that at all" because "they're cultured to not think that" there is no right or wrong answer in science. He understood this difficulty in enacting some of his sophisticated understandings of science, science teaching and reform, as resulting from students' history in science classrooms. Nathan indicated that it was vital for students to be exposed to reform-based science instructions and he explained "If [students] have had a teacher that has them do some inquiry, they can do more" (N/9/15/05 P.10). However, he explained that if students do not have a history of inquiry activities, then it becomes necessary to accommodate instructions toward being more sequential and prescriptive notion.

Although he understood that sequential and prescriptive science instruction can be applicable in specific environments for specific students, Nathan believed that focusing on rules and facts in science teaching was not an effective way to teach science. Nathan explained that emphasis on rules and facts may give students an impression that the science is a set of procedures to be memorized. Rather, Nathan favored a science instruction where students can experience "global understanding of science" (N/9/15/05

P.10). He explained that focusing on rules and facts isolated students from the reality that all sciences are interrelated. Nathan explained,

...it is because science is taught as descript bits of information. Right! I mean even in physics, ok, I could become an expert in particle physics, which is physics; I could become an expert in cosmology, which is the study of the structure of the universe; I could become a astrophysicist where I study stars and planets; I could become a theoretical physicist where all I do is sit there and scrub equations all day. So you know, even in physics, you know if you ask them, astrophysicists, how what they're doing applies to particle physicist. "Yeah maybe" but you are gonna be limited. So we don't teach the global perspective of science. (N/9/15/05 P.11)

Nathan explained that the current science teaching in our schools does not focus on "global perspective of science" rather it is presented as isolated facts and rules. He believed that without having been exposed to this "global perspective" of science, it is more likely that students dislike science because they view science as a set of procedures to be memorized. Consequently Nathan perceived that students should not necessarily have to memorize scientific facts and formulas; rather they should know the meaning of these constructs. He noted that there were many students during his middle school and high school years who were "successful" in science class but

...my teacher wanted you to memorize formulas.... she never asked what that formula meant in a real world situation. And that is what [students'] need to know. They need to know the formulas, yes, but then they need to know what they mean in the real world situation more. (N/9/15/05 P.12)

However, he thought that "...high school science teachers, not [the] science education community, we don't define being good at in science as being scientifically literate... Because if we did, we'd realize that we have to restructure the entire approach we take to teach science" (N/9/15/05 P.15). For effective science learning, Nathan believed that students need to understand science use in real world it is "because that is scientific literacy, everyday understanding and application of science" (N/9/15/05 P.15).

Nathan's initial beliefs about reform in science education were a consequence of his preservice education and his graduate studies

By virtue of being in the masters program, I am pretty familiar with [the reforms]. I've read cover to cover Inquiry in the National Science Education Standards (NSES); I've read National Science Education Standards. I've read parts of Assessment in the National Science Education Standards. And I've read the selections of the benchmarks, project 2061. (N/9/15/05 P.1)

Additionally, Nathan stressed that he was quite familiar with some of the accompanying articles and journals in terms of "learning theory and reform of learning theory, constructivism, and conceptual change" (N/9/15/05 P.1). Nathan explained that "we can achieve high standards of learning through the [use of] reform methods for all students" (N/9/15/05 P.5)

It is important to recognize that Nathan had not "bought into" the reforms wholesale, instead he recognized that there were some strong arguments against the reform movements especially NSES (NRC, 1996, 2000). To support his arguments Nathan cites Barton's argument on "is inquiry in NSES really equitable?" He highlighted, ...we talk about science for all Americans, but is it truly for everybody? Whose views of science are we putting forth? Even though we're talking about inquiry and all this other lovely stuff, there is still a goal that teacher has in mind, goal for understanding. There is even with inquiry a right answer. Dr. Alan, when I was an undergraduate did this pendulum inquiry activity, but her end goal for us is to learn that the period of a pendulum is effected by its length. There is an end goal, you know. So there are some problems with the reform documents... (N/9/15/05 P.5)

This quote demonstrates the fissures in Nathan's understanding of reform, in that he understood "science for all" as somehow contradicting science learning "for understanding." Because of this fissure, Nathan explained that while the reform documents were "the best we have [for] teaching science to all students", "in today's culture, high standards mean passing the state's achievement tests" (N/9/15/05 P.5).

Because of the pressures of standardized testing, and because he understood the reform of science teaching and learning to somehow be antithetical to the goal of conceptual understanding, Nathan explained that it is difficult for teachers to teach science through reform-based science instructions. Nathan also understood the context of

the classroom as serving as major barrier to reform of science teaching. “I mean the problem with the reform movements is they don’t stop and ask really ‘Well, ok is this necessarily possible given the climate?’ Yeah, I guess in a perfect situation. But the situation is not perfect” (N/9/15/05 P.5). Given the reluctance of students to learn in a way that is unfamiliar to them, Nathan understood the educational system to work to hinder teachers’ attempts to teach science through reform-based instruction.

Nathan quickly came to recognize that teachers are “fed up with the whole system” of schooling and because of this they fail to recognize the potential offered via the reforms. As new legislation requires them to make constant small changes in their teaching practices, he came to understand how teachers begin to resent and to resist the larger changes required in science education reform.

As far as practical requirements for successful reform implications in science education, Nathan explained that the state standards and other accountability measures for student achievement should be aligned with the reform implications for effective implementations of reform. Although he understood that the state standards somehow mirror the NSES (1996), in practice he saw that the standards and especially the state achievement test failed to allow for or motivate reform based instruction, as he described:

Nature of Science is very heavily pushed in the National Standards, but then we turn around and we have the standards based on the reform movement and we’ve got these ... testing policies that have nothing to do with what is pushed in the reform documents. If you look at the standardized science test and then mirror the goals of that, and just compared that to the assessment in NSES, you’re gonna get two different views. (N/9/15/05 P.1)

Nathan also decisively noted that the curriculum that science teachers employed should align with science education reform. He defined curriculum as “what you are teaching” and the “standards are theoretically what [students] need to learn (N/9/15/05 P.6). However, Nathan described that the texts actually employed in schools did not support the rigorous state standards, and he posited that when schools decide on a textbook, teachers select a text based on “its ease for testing” purposes” rather than its utility in teaching, mindful of the science education reforms (N/9/15/05 P.7).

Nathan's Initial Beliefs about Science Teaching

Nathan understood student learning to be a very complex construct. Based on student population and contextual factors, he understood that it was teachers' responsibility to find effective ways to facilitate student learning. Although he explained that inquiry was the "best way" to facilitate an effective science learning experiences, he understood that there were times that teachers need to heavily guide their students' learning experiences through prescriptive and sequential directions. He noted "Depending on what the experiment is sometimes you need sequential... I can't just be 'Here is some stuff and I want you to figure out [when] that is so foreign to them'" (N/9/15/05 P.10). Nathan explained sequential science instruction as methodological perspective and he believed "Science is very methodological, very, very method driven" (N/9/15/05 P.13).

This dependence on sequenced methods contrasted with Nathan's conception that that was "no one way to answer to scientific questions" and "if [students] are going from question to an evidential supportive conclusion; who cares how did they get there?" (N/9/15/05 P.13). According to his conception, after setting up a scientific question "[students] need to be able to follow through with an argument...provide evidence. But that doesn't necessarily mean that they have to do the same things all the time." Indeed, he heavily emphasized the empirical nature of scientific knowledge and scientific discourse, as he explained "you can't just say "all right, this is what I think." [That] is not sufficient in science" (N/9/15/05 P.13).

As another primary tool for understanding Nathan's initial beliefs about teaching and learning science, Nathan's teaching philosophy provided a profound account of his teaching goals. In it, Nathan quoted Langston Hughes' prose "It can shrivel up like a raisin in the sun. It can fester, or it can crust, or, in a worse case scenario, it can explode." Then he pointed:

Dreams are what keep us going. Dreams wake us in the morning, and dreams help us sleep at night. As teachers, it is our responsibility to foster the dreams of each of our students. We must help our students dream, and dream bigger. (N/ Teaching Philosophy)

Nathan believed that his ultimate goal as a teacher was to “inspire [students] to make their dreams come true” (N/9/17/05 P.9). He understood that that “scientists are the ultimate dreamers.” (N/Teaching Philosophy)

In order to achieve this goal, Nathan understood that there were several techniques to employ. Nathan believed that science is “...the systematic approach to understanding or explaining the observed phenomenon through natural needs” (N/11/11/05 P.9). Therefore, he understood that it is a science teacher’s responsibility to provide students with abilities and skills “to use science to help you live your daily life.” Through scientific literacy he wants his “...students to be able to critically think...pose and answer questions...” (N/9/17/05 P.10). His emphasis on scientific literacy (a major feature of the reforms) was woven throughout his teaching philosophy, although interestingly it did not feature prominently in his discussion of reforms. Through scientific literacy he wants his “...students to be able to critically think...pose and answer questions...” (N/9/17/05 P.10).

Nathan explained that in order to learn, science students must be actively engaged in science through “activities and demonstrations” (N/9/17/05 P.9). He indicated:

First, my students will be heavily involved in inquiry process. With inquiry our students learn science content. But, that is not all. They learn how to view the world and ask questions about what they observe. They learn how to set up experiments to answer those questions. They learn how to draw conclusions from data and they learn how to present those conclusions to others. They learn how to think critically and how to view a situation from several different angles. The skills my students will learn will help them today, tomorrow and for the rest of their lives.” (N/Teaching Philosophy)

Additionally, he believed “Being proficient in science not only means understanding science, but also includes being able to speak science, read science and write science” (N/Teaching Philosophy). Therefore, Nathan stressed the importance of the ability of “communicate science,” and at the outset of his induction year, he envisioned that his students would be able to learn it through his inquiry-based science classes. By reporting and sharing their experimental findings as well as reading science based magazines and papers, he hoped that his students would be able to develop

appropriate communication skills. Thus, at the outset of his teaching, scientific literacy was a major feature of his teaching goals.

In order to achieve effective science learning experiences for his students, Nathan highlighted the importance of inquiry, describing it as the “most effective way of learning science.” But, he explained that in order for teacher to use inquiry-based science learning activities, students must be “ready” for it. He indicated that “if I find my population doesn’t respond well to inquiry for various reasons, then I cannot do it.” In such situation, he notes that it is the teacher’s responsibility to “break down barriers” for students and he emphasizes on teacher role to find the best way for students to help them learn (N/9/17/05 P.8).

If they can’t handle inquiry, if they can’t get there yet, then it is my responsibility to teach them inquiry while I am teaching them content. If that means that some of the content is taught through more didactic method, then that is how it has to be. And what I hope is that I can break down some of those barriers. (N/9/17/05 P.8)

Nathan also pointed out that there is no “one best way for all” to learn science, and at the outset of his induction year he described that teachers should continue trying until they find the “best way” that enhances their students’ learning.

If there is one word to describe Nathan’s beliefs as a teacher at the outset of the induction year, “idealist” seems apropos. It is because of this strong idealism that Nathan selected Kent High, as he understood it to be like the culture of his own high school. He understood Kent High to have a student population that would allow him to make the most significant contribution to students’ lives. So, he decided to start his teaching profession at Kent High School, armed with a great enthusiasm to inspire students, supporting them in the pursuit of their dreams.

Nathan’s Initial Beliefs about Student Learning

Nathan believed that some students have a “natural talent” for science. He explained that some students are “more able to see scientific concepts, and then apply them globally” (N/9/15/05 P.9). And he identified himself as one of these “scientifically talented” learners. Based on his experiences during his high school years he understood

his aptitude for science to come from this “talent”: “I think that comes from a natural, and inherit psychological mechanism that allows me to process science easier or better.” (N/9/15/05 P.9)

However, Nathan understood that the most crucial requirement for science learning was not natural talent. Rather, effective science learning was related to student *attitude* toward science learning. He explained that students might learn small pieces of content but learning will not be profound as long as “[students] are not willing to learn.” Additionally, he understood that a learning environment could be very effective in providing effective learning experiences for students (N/9/15/05 P.9).

Nathan’s Initial Self-Efficacy

Nathan’s choice to teach Kent High is an important indication of Nathan’s high teaching self-efficacy and his high confidence in achieving his teaching goals. He believed in his skills and preparation as a beginning science teacher would allow him to make changes in the school and contribute to the lives of his students. Based on his content and pedagogical preparation for science teaching, Nathan had a very high personal science teaching efficacy and science teaching outcome expectancy.

In terms of his personal science teaching efficacy through the lens of his pedagogical preparation during his preservice years Nathan gained a profound understanding of the necessary steps and requirements to teach science concepts effectively by the means of science education reform implementations. Besides his current knowledge in science teaching, Nathan also noted that he was continually attempting to find better ways to teach science through his ongoing master courses and his personal exploration of effective teaching approaches.

Nathan envisioned no barriers that would prevent him from monitoring his students’ science learning and providing them with the best effective approaches to learn science effectively. Similar to his high self-confidence in his pedagogical knowledge, an investigation of Nathan’s initial self-efficacy revealed that Nathan was also very confident about his teaching skills and his content background in Physics. He felt he had the tools to teach ‘all kind of students,’ tools his preservice program provided for him:

I was prepared real well. You know, I know all different kinds of methods for assessment, classroom learning and teaching you know ESOL kids. I feel very comfortable in teaching students with disabilities you know all kinds of stuff. I did get a real good education. (N/09/17/05/ P.4)

He was confident in his content knowledge for Physics and he envisioned himself as being very capable of teaching physics in a reform based manner.

Along with his high personal science teaching efficacy, Nathan's science teaching outcome expectancy illustrated a very strong relationship between teacher effectiveness and students' achievement in science. According to Nathan, students' achievement in science was directly related to their teacher's effectiveness in science teaching. Thus, he perceived that his effectiveness in science teaching would have significant impact on the achievement of students, especially those with low motivation. He believed that it was primarily his responsibility to help students to achieve in science achieve. Thus, at the outset of his first year, in Nathan's view the teacher was central to learning effectiveness.

Nathan's Initial Pedagogical Discontentment

It was obvious that Nathan was very contented with his preservice preparation and there seemed to be no evidence that Nathan had any significant discontentment with his pedagogical knowledge or skills as he entered his first year of teaching.

Nathan entered the school year cognizant of the need to balance his teaching to orchestrate stability between the needs of both high and low ability-level students. Nathan perceived that to ensure an effective science teaching, his responsibility was to monitor his students' understanding through formal and informal assessment techniques to modify his teaching for "the best interest of all students" (N/09/17/05 P.1). Therefore, according to Nathan, teachers have to "take the responsibility" for their students and if their teaching is not effective then they have to find an effective way to teach (N/09/17/05/ P.1). Since he experienced success throughout his preservice experiences, he anticipated no serious barriers to effective teaching.

It was evident than Nathan perceived himself as being capable of providing effective learning experiences for his students and continually finding "alternative assessment tools" and "effective teaching strategies" to monitor his students' science

learning (N/09/17/05/ P.3). Based on the analysis of his pedagogical discontentment, it was evident that Nathan had little if any pedagogical discontentment at the outset of his first-year teaching.

Nathan started his first year of teaching with an idealist reform-based mindset through which he envisioned himself inspiring his students and engaging them with activities that would serve as effective learning experiences. He entered the classroom with low pedagogical discontentments, a high sense of self-efficacy, and a firm although somewhat naïve understanding of the reforms.

Changes in Nathan's Beliefs during his Induction Year

During his first year in teaching, Nathan understood his primary teaching responsibility to assist his students to understand “science and how it interplays with their lives” (N/02/03/06 P.11). Nathan defined his central goal as the preparation of his students to be successful adults. For Nathan, content learning came after this preparation for adulthood. As a science teacher, his responsibility was to enhance students’ understanding of science including Physics, Chemistry, and Biology and eventually Earth Science. Nathan explained “I became a teacher so that I can put my students in a position to maximize the output that is their adult life.” (N/02/03/06 P.11)

Changes in Nathan's Beliefs about Science

In light of his robust understanding of the nature of science (NOS) molded during his preservice learning, it was not surprising that Nathan devoted his first two weeks in teaching to NOS. He explained “I am very satisfied with the NOS because those are things that I do, content free activities. It doesn’t really mater if we are doing it in earth science or in physics.” To teach NOS Nathan designed many activities to help students understand scientific methods, to pose and answer questions, all in the effort to help students think “critically for global understanding of science” (N11/11/05 P.5). Nathan aimed to have his students constantly question “What does that mean?”

Mindful for the student population he served, Nathan also wanted to emphasize that science is not just a venue for “white men.” For the “minorities in science” lesson, students were to draw a picture of a scientist. With this staple NOS activity, Nathan attempted to break down the perceived racial and gender barriers to science that many

minority students come to the class. Nathan began this activity by asking students to “draw a scientist”--no other directions were offered. If a student asked for clarification, Nathan simply offered the statement again. For this, he provided students with a blank sheet of paper and colored pencils.

The racial make up of his class was about 50% white, 50%African American and 50% boys, 50% girls. After the students had drawn their pictures, he asked everyone to stand up. The classes had about 30 students. Nathan then asked his student who drew a male scientist to sit down. Only one student, a girl, remained standing. He asked each student to stand up again. This time Nathan asked each person who drew a white scientist to sit down. About 25 students sat. Then he asked those students who drew white male scientists to explain their selection.

After listening to students’ reasoning of their white male scientist drawing, Nathan organized a whole class discussion about how their ideas of a scientist conform to the larger societal portrayal of what it was to be a scientist. After the discussion, Nathan listed examples of where these ideas came from, and how society as a whole prescribed to individuals specific norms. Lastly, he took particular care to identify female and minority scientists that made contributions to science. Specifically, Nathan talked about Marie Curie as a Nobel winner woman scientist, an African American scientist who lived in the town where the Kent High School was located and was a graduate of the university in the town as well as several other scientists.

Because of his students’ lack of previous exposure to NOS and scientific inquiry, Nathan realized that special attention was necessary to equip his students with the basic skills and understanding of Nature of science and how science was performed. During his early stages of his first year, he tried to do several “predict-observe-explain” NOS activities during his early teaching at Kent High School. (N/11/11/05 P.3) In another staple NOS activity, Nathan demonstrated that our assumption and perceptions about the object would not always represent a proper explanation for a phenomenon.

For this activity, he used two soda bottles filled with a liquid in them. The liquids had almost the same color. The only difference between the soda bottles was one had a brand paper on it with the well known Coke trademark, and another one did not have any name tag on it. Once he set the bottles in front of the class, he asked his students predict

the type of liquid in each bottle and asked student to make predictions. Based on the physical descriptions of the bottles, students assumed that the one bottle which had name tag on it had “Coke” and another had something similar to this. Then Nathan asked his students how they could confirm their answers without tasting it. Several students indicated that if they would shake the bottle they would observe some gas streaming out from the bottle. Nathan shook both bottles, and asked his students for their observations. Students observed that when the bottle which had the Coke tag on it did not have any gas streaming out, however, the other bottle had gas escaping. Then Nathan asked his students about their final decision about the liquids of the bottles. During this discussion, each of his students confirmed that their initial prediction was not accurate. Nathan wrapped up this activity highlighting the significance of scientific methodology in scientific inquiry to understand a natural phenomenon.

As far as his students’ receptiveness to NOS activities, Nathan believed “...it seems that [NOS activities] are their favorites, their favorite days are NOS” (N/11/11/05 P.2). Thus his knowledge about NOS as well as his knowledge in teaching NOS was a central part of his early teachings.

Changes Nathan’s Beliefs about Science Education Reform

At the outset of the year, Nathan’s goal was to teach through reform-based science methods. Nathan explained “I like them. 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” (N/03/01/06 P.10). Nathan perceived that when he was first exposed by the reform-based teaching, he thought “...This is ridiculous! What you want me to do, just labs all day” (N/03/01/06 P.7)? Thus, as an undergraduate student Nathan believed “teaching through inquiry means you always doing labs and never do a lecture ...” (N/03/01/06 P.12). Thanks to the broader theoretical and practical underpinning of science education reform given by his teacher education program, Nathan came to realize that reform suggestions in science education did not require teachers to teach science through inquiry all the time.

During his first-year experiences Nathan came to understand that it was feasible to teach mindful of science education reforms, however he also understood that effective

implementation of the reforms strongly depended on many contextual factors. These contextual factors included students' cognitive inclinations and motivation to learn science in a reform-based classroom context, alignment of curriculum, textbook and supplementary materials to support reform-based instruction, cooperation among the teachers and administration as well as through the state level curriculum and accountability adjustments, the robust compatibility of state level educational system with the reform-based teaching and learning activities.

The influence of these contextual factors in shaping Nathan's beliefs and his inclination to enact reform was explicitly discussed in Chapter 5. It is interesting to note that when the reforms were invoked in our discussions during his induction year, Nathan remained supportive of them, but more tentatively supportive. However, when we look at other aspects of his teaching beliefs, many of his views changed in fundamental ways that were antithetical to the reforms--but his ties to the explicit language of the reforms remained strong.

Changes in Nathan's Beliefs about Educational System

Nathan saw three different purposes of the educational system broadly conceived. One of the goals was to produce an "equal society;" the second was to produce necessary work force; and the third was to "allow [students] can get ahead to get ahead" (N/02/13/06 P.8). He noted that teachers should behave differently depending on which of these three goals they were pursuing. Nathan explained:

I'm still struggling with the question: Why I am a teacher? Why do we have schools? Am I teaching science for those five kids that will ended up being scientists? Well then my teaching needs to prepare them for rigors of a college science education. Am I teaching science to make good workers? Well then I need to reform my teaching in a wholly life adjustment curriculum manner. Am I teaching for some sort of egalitarian science for all Americans? (N/02/13/06 P.8)

Despite, or perhaps because of, the murkiness of these three goals, Nathan came to an understanding that the only thing that the science teachers "needed to know" was the state curriculum standards.

During his first year teaching at Kent High School, Nathan understood that “The goal of the school is to make every student as good as that student can be to get them as far along their potential track as they can during their four years in that school” (N/03/01/06 P.9). In order to achieve this goal, Nathan realized that the entire school should proceed via team work. Nathan explained that before he started his first-year teaching, he perceived that teaching and learning was an “individual responsibility” (N/03/01/06 P.9). However, he quickly came to realize that it is crucial for teachers to work cooperatively if they are to be effective.

Too, at the beginning of his teaching career, Nathan described that he was “very idealistic” and he explained that in order to make a change “you wanna have idealism and you wanna be saving the world” (N/12/26/05 P.2). After his first several-week exposure to teaching profession at Kent High School, Nathan realized “Education [the system] is bigger than just educating our kids” (N/12/26/05 P.2). Nathan realized that there was a conflict between what teachers and policy makers expect from education.

Changes in Nathan’s Beliefs about Standards/Achievement Tests

Nathan thought of the state standards for science as outcome standards (meaning declarative knowledge of specific science content), whereas the NSES (NRC, 1996) were not only outcome standards but also process standards (the ability to inquire in science). Nathan understood that the NSES served as a guide for science teachers about what to teach and how to teach -- and he began his school year with the thought that they should serve as teachers’ sole guide for instruction. However, soon after entering his first-year teaching, he realized “it is easier said than done” (N/03/01/06 P.3). And the main problem in using NSES that Nathan realized was that these standards did not align with the contextual realities in his school.

Nathan started his teaching with a belief that the state standards and achievement tests contradicted the reform movements; thus, given his adoption of national reform rhetoric, he began the school year by denying the validity of state standards and accountability implications in science teaching. After entering his first year, he noted “I swung over to the other side thinking that [state standards] were the greatest things on sliced bread” (N/03/01/06 P.12). After teaching for a few months, Nathan came to believe

that reform implications in science education did not contradict with standards and accountability. For Nathan, the current system of education in his state recognized each individual teacher as being responsible to determine “what the standards require.” (N/03/01/06 P.12)

Nathan initially noted that there was a contradiction between his teaching goals and achievement testing; he did not want to “become a teacher” who simply wants his students to pass the achievement test. Rather, he stressed “he became a teacher to “inspire” his students and help them to “leave Kent High School better everyday from 7:30 to 1:30” (N/02/03/06 P.10). However that quickly changed.

Nathan explained that during his preservice year, his preservice program introduced the state achievement test as “the worst thing that was ever thought for education” and “it entirely ruins the education” (N/03/01/06 P.4). Based on his preservice education, he understood there to be little validity to state achievement test. Nathan indicated that among his preservice friends only Bob, a “voice in the cold,” viewed the achievement test as a valid instrument to ensure that all students receive a body of standardized knowledge. Nathan noted that he and Bob had serious discussions during their graduate classes and at the time Nathan disagreed with Bob’s belief that the achievement tests work to ensure that all students learn the basic knowledge within a state. Rather, at the outset of the school year, Nathan thought that the achievement tests only hindered the notion of “equity” among diverse student population and the “quality” of education through dictating a system for entire state (N/03/01/06 P.4). After his first semester at Kent High School as an Earth Science teacher, Nathan came to an understanding that the state achievement test was a “valid test” but “not perfect.” According to Nathan, the achievement test served “a purpose” and it was “a reality,” which every teacher had to confront at Kent High School. (N/03/01/06 P.5)

As Nathan began his first-year teaching, he realized “nobody is assessing you whether you’re teaching through inquiry or not. Your job, your livelihood is dependent upon your ability to get your kids to pass [the test]” (N/03/01/06 P.6). According to Nathan, there was a great amount of pressure on teachers to prepare students for “the test.” Nathan illustrated that his school administration prescribed the expected outcomes for his teaching, and accordingly, they also defined how to achieve these expected

outcomes. Consequently, Nathan noted “I had no choice on how to deliver my content” (N/03/01/06 P.6). Unlike the common belief in education that teachers have freedom to make changes for their curriculum, through Nathan we come to see that there are many influences on teachers, especially on beginning teachers.

Quickly into his first year, Nathan changed from being a teacher with the goal of helping students become scientifically literate, of preparing them for later life and for inspiring them, to a teacher with the goal of preparing students for success on a standardized test. He began to understand that his “job depended” on his students’ performance. It was later in the school year, after he adapted himself into his teaching context in ways to best ensure his job stability, that Nathan realized that reform-based science had become “a forgotten ideal” in his teaching (N/03/01/06 P.6). Later in the school year, Nathan realized that his initial notions were naïve and but he was flummoxed by the degree to which these naïve ideas had been “hampered” by the overwhelming concerns and practicalities of classrooms and schools. At this point he became frustrated, and instead of the “ivory tower” approach to state testing he received in this preservice preparation, he longed for discussion that would better prepare him to deal with accountability measures in thoughtful ways. Into his first year, Nathan longed for “a true perspective of the state achievement test” as situated in real teaching contexts (N/03/01/06 P.6).

Changes in Nathan’s Beliefs about Science Teaching

Similar to his initial beliefs about science, during the middle of his induction year, Nathan continued to define science as “natural explanations for observable phenomena” and he believed “inquiry is the most effective way to teach science” (N/03/01/06 P.1). Nathan perceived that the effectiveness of inquiry originated from its central emphasis on enhancing and improving students’ global understanding of science. Therefore, the traditional attempt to cover relevant content knowledge in science classes was not sufficient for his students’ global understanding of science. Rather, he argued that his students needed to know and discuss the political and social implications of science. Thus, for Nathan “Science is the search for the knowledge about the universe and that is what we need to represent science is.” (N/03/01/06 P.1)

This seems to be the portrait of his beliefs about teaching at the outset of the school year, but by midyear these beliefs were not reflected in his teaching practice. Likewise, Nathan believed that his preservice education provided him with a sufficient theoretical background to teach science for various student populations. He understood knowledge of special approaches to teaching science for the particular student population found at Kent High School. In spite of his initial reform-oriented beliefs about teaching and learning, Nathan struggled throughout the first year to understand what “Science for All” means in an actual teaching context. During this year, he came to think that because of the wide range of student abilities in his classes, it was impossible to reach all students and teach them science effectively. Too, during this first year he came to understand that there were always some students that a teacher “could not reach” because of specific student characteristics and abilities--a mentality that represents a stark shift from his incoming beliefs about teaching (N/02/17/06 P.5).

During the midterm of his first-year teaching at Kent High School, there was also remarkable change in Nathan’s teaching goals. In terms of science teaching, during his midterm in teaching Nathan struggled to define what effective science teaching ‘looked like.’ His midterm teaching goal was “to weed out and produce the best possible scientists while not really caring about the rest” (N/02/17/06 P.1). Because of what he perceived to be his students’ lack of interest in learning, Nathan explained that the “amount of time I devote to a topic is definitely dictated by the student that expresses interest.” And based on their interest, Nathan explained that for some classes that were not interested in learning science, he “turned them loose,” meaning he assigned readings and vocabulary words without much teacher guidance or direction. Whereas for his interested and motivated classes, he “[held] their hand” --which for him was represented by discussions and animated mini-lectures on engaging ideas--not necessarily following ideas from the book but ideas derived from the content that he and the students found engaging (N/02/17/06 P.1).

By the mid-point of his first year, Nathan came to believe “there are kids that definitely don’t necessarily need to be there. And it is a horrible thing to say but...” (N/02/17/06 P.7). During this first year, Nathan came to understand the ‘science for all’ aspects of the reform as “undoable” in a real classroom, and because teaching was so

taxing and difficult, he invested his energies in those students that were engaged and were interested, but from a science education point of view, the nature of the way in which he did invest his energies is very telling, as will be discussed.

During his first-year teaching at Kent High School, it was evident that Nathan adjusted his beliefs about science teaching as well as his practices because of the contextual realities of his teaching context. And the most influential facet of his teaching context was his students. Although Nathan believed that science was universal and science teachers should represent science “the same” in every context (N/03/01/06 P.1), he explained that his student population significantly influenced the way he taught science, so that he needed to adjust his way of representing science based on his student’s expectations.

During the course of his first-year teaching, Nathan realized that the culture of the school where he teaches influenced his beliefs and practices of how he taught science. According to Nathan, where the Kent High School is located is called Bible Belt and the mainstream culture in the area is considerably shaped by concerns of the religious right. On many occasions in his first-year teaching, Nathan realized that some of the Earth Science content created controversy in his classroom. He explained that because his students are mainly from conservative Christian families, some scientific explanations are antithetical to their own cultural beliefs. One of the main controversial issues that Nathan had in his Astronomy class was Big Bang. On several occasions Nathan and students discussed the difference between the epistemic weight of the big bang theory in science as to apposed to how it is viewed by many religious groups

In one of his classes, he discussed the Big Bang and three main scientific reasons why Big Bang is a valid scientific theory to explain the origin of the universe. Initially, Nathan perceived that the class was very successful and represented an important “teachable moment,” where, by hitting upon a commonly interesting topic, teachers can teach science effectively. According to Nathan, this class session represented one of the teachable moments for him. However, after reading the transcripts of the class that I provided, Nathan realized that the class was not as effective as he assumed. He understood this lesson to be less than effective because of the organizational issues and his lack of control over the class.

During the class, a group of students expressed that based on their religious beliefs the origin of the universe is not similar what science proposes. They explained that God created the Earth in couple of days and during that time the universe was also created. However, Nathan explained that the Big Bang was the scientific explanation for the origin of the universe--what science understands to be valid. Nathan explained that in a science class they need to focus on scientific point of view--he also took this as an opportunity to focus on the boundaries between scientific and religious ways of knowing.

Almost half of the class expressed their opposition to the Big Bang as a valid explanation. Some of his students argued that they do not believe in Big Bang but they want to learn what the theory suggests about the origin of the universe. It is important to that that during this terse discussion, Nathan did indicate that what he believed about the origin of the universe was very similar to his students' beliefs. According to Nathan, individuals can "believe in God and also believe in science" at the same time without having any contradictions. However, when students freely represented their point of view about the origin of the universe, Nathan indicated that he "took it personal"--understanding NOT that his students were trying to share their views, but understanding that his students were refusing to listen to him (and so to the voice of science). Nathan explained that because of their overwhelming religious culture, his students rejected what he was presenting in class.

Nathan perceived that his role as a science teacher was to not to marginalize his students, rather, to provide them a "midway" to understand and negotiate these controversies (N/03/01/06 P.1). However, it is important to note that when students presented their views, the assertions of their home cultures, he did not use this opportunity as a way to construct this bridge between their home and science communities. Instead, he understood his students to be unwilling to participate in any sort of compromise--something he understood not in epistemic terms, or cultural border crossing terms, as the reforms might suggest, but as a personal affront.

Changes in Nathan's Beliefs about Student Learning

At the outset of the induction year, Nathan understood that science learning was most effective when it was sparked and propelled by questions. However, it was evident

during my observations that students did not feel comfortable asking questions or did not feel compelled to ask questions in Nathan's class. Nathan's classroom began to echo those of many of his colleagues, in which the material was teacher driven and students were largely silent. This change in his practice of science teaching also seemed related to a change in his own thoughts about questions and their role in student learning.... Thus, he noted "you can't force a kid to ask questions they don't have" (N/02/17/06 P.4). However, he indicated that he could be more effective in encouraging students to ask questions, indicating that this belief in questions was not completely abandoned, but certainly muted.

Initially, Nathan held the learner and the teacher as intimately responsible for the learning that happens. Students needed to bring with them a willingness and motivation to learn; teachers needed motivate through addressing their students' needs and facilitating activities to structure an exciting learning environment. But early in his first year, he came to factor parents into this equation. Nathan perceived that it was parents' responsibility to help their students to become motivated for learning. He came to view parents as those most responsible for their children's low performance--not the students and not the teacher. He noted "the parents don't value education so then kids don't" (N/02/17/06 P.3).

Thus, we see the vast changes in Nathan's beliefs about teaching during his first year--beliefs that were heavily influenced by the context in which he taught. He came to understand that only a few students were capable of learning science--a capability that was determined by motivation and engagement. But he came to see these being attributes as more heavily influenced by the context, community and parental structure than influenced by the teacher's actions. Thus, he came to understand learning to be very contextually influenced, with the teacher having very little influence in this context.

Changes in Nathan's Self-Efficacy

Nathan, as a first year science teacher, had a very high degree of self-efficacy in his science teaching abilities and personal skills. This sense of self-confidence as an individual also influenced his teaching self-efficacy beliefs. He entered the school year fully expecting to be able to create effective science learning experiences for his students,

even in a school in which student motivation and achievement were often marginal. Therefore, Nathan's decision to start his teaching career at Kent High School provided a crucial account of his high teaching self-efficacy.

It is interesting to note that during the first year at Kent High School, Nathan's identity as a competent, idealistic, nontraditional, champion of the student did not change significantly. This, though, was in stark contrast to his personal teaching-efficacy and his outcome expectancies. Both these constructs were diminished during this first year, and Nathan understood these changes as a consequence of his teaching context. He understood that his teaching context prevented him from achieving his personal teaching goals; it was the context that prevented him from being able to teach well; and it was the context that shaped his dismal view of his students' abilities to learn.

Interestingly, this more modest self-efficacy and outcome expectancy did not drive Nathan to watch "more knowledgeable others." Similar to his preservice years, it was evident that he relied so much in his own skills and abilities that he did not feel compelled to watch other teachers teach--not the highly capable department head or any other teacher at Kent High.

Personal Science Teaching Efficacy

An investigation of changes in Nathan's personal science teaching efficacy revealed that Nathan's content knowledge and pedagogical knowledge played significant role in shaping his personal teaching efficacy. The following sections provide a close look at the interactions between Nathan's self-efficacy and his content and pedagogical knowledge correspondingly.

Interaction between Self-Efficacy and Content Knowledge

As far as the interaction between Nathan's self-efficacy and his content knowledge, Nathan's lack of content knowledge in Earth Science appeared to be the source of several struggles for Nathan. Indeed, it was clear that Nathan did not understand the Earth Science concepts well enough to be effective in teaching them. He explained:

I don't have this repertoire of earth science experiences. The last earth science class I took was in 8th grade. I was in eighth grade in 1995-1996, ten years ago. I

don't have experiences, you know. I remember labs when I was in physics. I remember when I was in chemistry. I don't remember labs when I was in earth science. I don't even know if we did labs when I was in earth science.

(N/09/17/05/ P.2)

Despite high self-confidence in teaching science in general, often he was not sure of the accuracy of the earth science content he taught. Nathan explained "...things come out of my mouth, and I am not sure if I'm right or not." He understood that to teach an effective Earth Science class he needed to know the content very well. And he noted "I spend a lot of time learning the material as opposed to synthesizing it in a good lesson." (N/09/17/05/ P.4)

Nathan also faced the similar content knowledge/self-efficacy interaction in his Astronomy class. Despite the fact that he had a relatively high content knowledge in Astronomy, Nathan's teaching was remarkably similar to that in his Earth Science class. Although he understood the Astronomy content well enough to teach it effectively, he taught the class by lecturing without facilitating any activities and labs. Similar to his Earth science classes, Nathan did not plan for his lessons, but unlike the Earth Science class, he had no specific curriculum to teach his Astronomy class. He made his choices on **what** to teach in Astronomy class, but did not place a similar emphasis on **how** to teach it. Nathan noted that during the second semester he taught quantum physics for first four weeks--and most of this was conducted via lecture and discussion.

Looking at the assessment scores, Nathan recognized that his teaching was effective for a small number of his students in astronomy, whereas the majority of his students did not learn quantum mechanics very well. He understood this failure to be due to the level of subject matter (in relation to the students' abilities) and lack of supplies to support student understanding.

As far as his self-efficacy/content knowledge interaction, Nathan's attitudes toward student questions also shed insight into personal teaching efficacy in term of his students' content knowledge abilities. Nathan described that there were certain types of students who performed very well in his classroom. Nathan explained that these students were the students who "value to be successful" and were "interested in learning." Nathan specified that when he presented something interesting to his students, he received

different reactions from his students. Some of the students who held lack of motivation for entire schooling seemed to ignore and “turn off” to learning and some were very interested in future exploration. Additionally, Nathan explained that when his students were interested in learning and further discussion on a topic, he perceived that students viewed him as their “authority on physics, on science” and when he explained something they easily believed him. (N/02/13/06 P.10) He described this feeling as one of the nice things of being a teacher that Nathan experienced.

However, Nathan noted that this interaction was at a contradiction with what the state science standards promote. Nathan explained that the state and national standards promote students’ ability to question, rather than accepting what teachers teach. However, his willingness for students to question had definite boundaries, which Nathan himself recognized. He lamented that when his students questioned science in contrast to their own religious beliefs, the first thing Nathan did was to stop the students with his immediate counter arguments. Thus, he realized that he was neither comfortable with nor effective in fostering students’ questions.

Although Nathan theoretically perceived the significance of student questions in science learning, based on characteristics of his students and the nature of their questions he sometimes perceived student questions as threat to his teaching, and then he often ignored the questions or comments. If he perceived students’ questions as an attempt to clarify something, then Nathan preferred to give the right answer immediately rather than valuing these questions as opportunities to allow his students pursue their curiosity to learn more. While Nathan knew that he was “supposed” to value questions, this value failed to transmit into his classroom actions, something that lowered aspects of his science teaching self-efficacy.

Interaction between Self-Efficacy and Pedagogical Knowledge

Although Nathan initially believed that he was able to efficiently monitor the effectiveness of his teaching, this belief eroded over the school year. A close look at Nathan’s attempts to monitor effectiveness of his teaching and his students’ learning illustrated Nathan’s low self-efficacy in using various different assessment methods. For example, in one of his Earth Science classes he designed an activity to help his students

to visualize, in three dimensions, features represented by contour lines on a topographic map in his second semester. During the activity, his enthusiasm and willingness toward the activity was obvious from his gestures during his lecturing. In contrast, it was evident that students' participation in the activity was very limited since the manner in which the activity was presented was very teacher centered and students were to follow a focused set of directions. Although the activity would be a very engaging and effective tool for supplementing his classroom teaching, his lack of preparation for the activity hindered its effectiveness. Rather than acting as a facilitator, evidently getting his students to complete the activity appeared to be his primary purpose during the activity. To compound this, Nathan did not have an assessment identified for this activity, so it was difficult for him to assess his students learning from the activity. In spite of his initial perception that the activity was very effective and students enjoyed it as much as he did, the following day he realized that the students had not enjoyed it and he had very little sense of what they had actually learned from it. On both counts (interest and conceptual gains), the activity had failed.

This "black box" approach to teaching also held true for his astronomy class. He explained "I have no idea....And it is one of the most frustrating things about my job. I sit there and I have no idea if they have learned it" (N/12/26/05 P.2). By mid year, he no longer saw himself as an effective science teacher in terms of his assessment abilities.

Another significant indication of his lowered self-efficacy was seen in his assessment of his potential to facilitate effective science learning experiences for his students. Nathan essentially believed that the heart of science learning was targeted to inspire students to become critical thinkers. To achieve this goal, at the beginning of his first year Nathan emphasized allowing his students' to express their ideas about political and social facets of science through open whole class discussions. Despite the emphasis he placed on promoting his students' critical thinking abilities, Nathan realized that most of his class discussions seemed quite "wild" to his students and the students did not feel comfortable in such conversations. For Nathan, in his students' perception, there were always right answers for questions and when the students were challenged, "First they get frustrated: 'just tell us the right answer'" (N/09/17/05/ P.7)! It was one of the expected

results of change attempts in a classroom. He no longer thought of himself as a teacher able to quell these frustrations.

It is important to note, however, that Nathan largely understood his teaching difficulties to be due to students' limited science background and their low cognitive levels. Thus, rather than attempting to prepare his students to assume new roles as learners, and searching for alternative ways to provide more effective learning experiences for his students, Nathan adopted his teaching style to the way in which his students were accustomed.

When discussing his limited attempts to improve his teaching, Nathan indicated that he could be one of the reasons for the ineffective teaching and learning activities in that particular teaching context. Nathan noted:

I am not also willing to go out of my way and make the class better. If you look at my plan book my "do book work one day, take notes the next, book work-notes, book work-notes, and test, done." ...I have enough on my plate for this semester. I don't care anymore. They [The students] made the choice, and I told them at beginning of this semester I said "We're gonna start new, and I am gonna treat you like we've never had a class together." First day they were off the wall.
(N/02/03/06 P.12)

His lack of attempts to find more effective ways to assist his students sometimes resulted in dramatic situations in which he came face-to-face with the fact that his students were not learning. Rather than seeking alternative approaches to enhance his students' learning he "apologized" to his students and openly expressed his lack of competency and preparation to teach Earth Science (N/12/26/05 P.5).

Outcome Expectancy

During his first year at Kent High School, Nathan realized that many of his students did not benefit from his teaching, something he attributed to his students' lack of engagement. Indeed, he believed that their reluctance to engage in school was the cause of their constant underachievement. Nathan explained "I'm not saying it's a conscious choice they make. But it's not even a choice...It's this evolution of values that has such pressures." (N/02/13/06 P.10) Similar to his high school learning experiences, Nathan

perceived that “today’s students” mainly value “their friendship and their social status.” Within this culture Nathan understood that being successful at school was not “socially acceptable” among the students. Soon, students lose their faith in their abilities; they started believing “Well I know I’m not gonna be successful. Why even try?” (N/02/13/06 P.10)

Nathan realized that in order for him to teach science effectively, his students needed to have complex skills and sufficient background knowledge--and a lack of both of these largely shaped his outcome expectancy. Nathan noted “...you can’t teach the skill and the content [at the same time] and so I stumbled coming out of to the game.” (N/12/26/05 P.6) By mid-year, Nathan believed that he was not able to achieve his teaching goals with the majority of his students. He began operating from a deficit mentality about his students.

Overall, Nathan believed that effectiveness of science teaching depended on students’ willingness, their motivation to learn and their prior science background as well. Nathan came to believe that the effectiveness in science teaching had little influence on the achievement of students’ with low motivation--thus he no longer used student learning as a measure of the effectiveness of a lesson. Thus, he explained that even teachers with good science teaching abilities cannot help “some kids” learn science.

Changes in Nathan’s Pedagogical Discontentment

One of the most profound changes in Nathan during this first year had to do with his sense of pedagogical discontentment. To understand this discontentment, first we must focus on specific classroom practices.

Changes in PD for Teaching Inquiry-Based Science

At the beginning of his first year of teaching, Nathan attempted to use specific activities to help his students to better understand the NOS. He employed staple NOS activities (e.g. Draw-A-Scientist, False Assumptions, and Perception is not always reality); however, these activities were limited by the time frame of the beginning term of his first year. Thus the integration of NOS did not appear as a prominent part of his teaching across the curriculum. Additionally, the nature of these NOS activities were not presented in an inquiry-based learning approach so that his students were not able to

assume new roles as learners in his classroom. Indeed, many of these activities appeared as more of a demonstration format. Nathan often designed the activities in this stage and asked his students to participate in an “observe, predict and explain” format of teaching.

Although he identified himself as a theoretically well-equipped science teacher, Nathan recognized the mismatch between his initial teaching ideals and his classroom practices throughout his first year. Nathan expressed that during the course of his first year experience in teaching he was not an effective teacher. Nathan noted his discontentment as “When I started I thought I was I thought I was that good, and I was pretty good but I wasn’t as good as I thought I was.” (N/02/17/06 P.1)

While his teaching methods somehow varied through his different classes, his teaching became overwhelmingly didactic and lecture oriented. Nathan illustrated a strict teacher-centered teaching style where he provided students with no or very limited opportunities to participate in classroom discussions. Nathan explained:

I just write a sentence on the board and I write the next sentence on the board and then next sentence on the board and next sentence on the board because it isn’t worth it anymore to me. (N/01/13/06 P.2)

Clearly, Nathan saw that many of his students were not learning in his classroom. By the end of his first semester of teaching, Nathan realized the fact that his teaching was not effective and his students were not interested in his classes. He confirmed that he needed change his way of teaching and mold more thematic units in Earth Science. Nathan stated:

...we’ve got a routine, we take notes and I wash my hands and we’re done for the day. And it is miserable that we’ve gotten that routine. You know I am gonna switch it up a little bit. We’ll do more out of the book maybe. You know I don’t wanna be. It is hard. You know I wanna teach more thematic units in earth science, talk about energy consumption and things like that. (N/12/26/05 P.4)

Besides lectures, note taking was another keystone component of his classroom teaching. Based on his high school experiences, Nathan found that note taking was one of the learning strategies that helped him for his science learning. To better teach Earth Science, he tried to require his students to keep a notebook for daily notes. However, he realized that many of his students seemed reluctant to participate in this. In order to

motivate his students, he collected students' notebooks and graded their notes during the following semester. However, Nathan came to think that requiring his students to take notes did not really help them to better understand the content.

Nathan developed a growing discontentment around his first-year teaching practices--however, he understood these discontentments to stem largely from contextual issues, and less on his own inabilities.

Changes in PD for Teaching across All Student Ability-Levels

A second source of Nathan's pedagogical discontentment revolved around his classroom management skills. However, although he recognized his limitations in this area, Nathan recognized this limitation to be primarily attributed to context. He explained that it was because of the "level" of his students that he had this management problem. At the very outset of the induction year, Nathan envisioned himself to be teaching the group of kids who were college bound high school students. On the other hand, all of his classes were 9th graders, a mixture of 9th graders representing every end of the ability and aptitude spectra. Consequently he noted "what I know would work for older kids, and therefore doesn't work for younger kids" (N/11/11/05 P.1). Thus, while his management was in some ways a source of pedagogical discontentment, Nathan again understood it in contextual terms--as being caused by his very specific teaching context.

Very early into his induction year, he realized that his preferred teaching style (that which he thought appropriate for more "advanced" students) did not seem to be a good fit in this particular teaching context. This realization reflects Nathan's pedagogical discontentment in which he realized his skills were ineffective in teaching science to younger, less able students. It is important to note that Nathan continued to conceive of himself as very successful with the students who were motivated to learn.

Changes in PD for Resolving Depth vs. Breadth Content Issues

As far as his ability to organize a successful balance between covering a wide range of material and engendering deep student learning, Nathan faced a challenge to extend his students' understanding of the content. For example, at the beginning of the second semester in his first block Earth Science class Nathan focused on graphing, which was a part of the state curriculum standards. He worked to teach his students to draw a

graph given a set of data. Although his students were capable of drawing the graph, Nathan saw them as incapable of recognizing patterns in their graphs. Likewise, they were incapable of drawing conclusions based on a graph. While he wanted to extend their knowledge to something “deeper” he was unable to do so. Nathan again attributed this inability to contextual factors. He explained that it was because of his “department’s pressure” on him that there was not enough time for him to foster his students’ understanding of graphing. He thought he would be able to assist his students, if only he had time (N/03/01/06 P.11).

Another aspect of Nathan’s pedagogical discontentment revolved around his ability to balance his own science teaching goals with those of state and national standards. Before the second semester started, Nathan expected to be successful teaching his Astronomy class because of his strong content knowledge in Astronomy and the student population from this class drew (mainly higher grade level students who would be responsible and more receptive). Since the class was elective and it was not part of the state achievement test, Nathan was able to teach them topics that he personally found interesting. Nathan noted “I sit here and I say “What parts of science did I find interesting especially in astronomy?” So we’re gonna talk about how according to quantum theory you can walk through a door.” (N/02/03/06 P.2) Nathan believed that the curriculum was exceptional so that maybe only five hundred high school students across the U.S. would have the opportunity to learn the materials that his students would learned.

His curriculum choices were overwhelmingly influenced by his teaching goals and interest, rather than the state standards or his students’ needs. Although Nathan believed that the state standards outlined what is important for students to learn, the lack of a state standardized assessment for this course allowed him to put this consideration to the side in his astronomy class.

Because of this, Nathan talked (indicating lectures with limited discussion) about Big Bang for four weeks. It became predictable that some of the same students would continually focus on counter religious arguments to the material presented. Nathan noted “I generally ignore them, but part of me questions whether they say it to instigate me or other people or whether they really believe that.” (N/02/13/06 P.5) Nathan specifically recognized one student who always says “That’s not the way Bible says.” (N/02/13/06

P.5) Nathan explained that he did not know how to approach these students because the student population at Kent High School was diverse both religiously and politically. Besides his lack of experiences in managing controversial discussions, his lack of attempts of integrating NOS throughout the curriculum resulted in his difficulty resolving such controversial content issues. And similarly, while he understood that his approach was not as effective as he hoped, and he experienced some discontentment in his regard, he found that most of the explanations for his difficulties were NOT in his approach, but to the conservative mainstream culture of the area.

Changes in PD for Assessing Student Learning

Nathan understood that if some aspect of his teaching was effective, this would be manifested in his students interest in the class--something he could measure via "...that "aha face" that they make" and he understood that "face" as a very strong sign of their learning (N/11/11/05 P.3). In addition Nathan explained that students' misunderstandings were often reflected in their questions.

If my students are questioning which is the X axis, then they're not learning necessarily the information that is presented on the graph because they can't understand the graph. Ok, so even though, they maybe able to tell me the right answer or they may have gotten lucky in their graph, they are right. When they say which one was the x axis again? That is a probably the decent indicator that "all right we need to revisit this." (N/11/11/05 P.3)

In addition to students' immediate reactions, Nathan used tests and homework scores to understand the effectiveness of his teaching. And he stressed,

If they're testing well, then they probably know what they're talking about. You know, multiple choice tests are great but you can beat multiple choice tests. I don't give multiple choice tests. They got to write for me, they got to read you know. I look for that. (N/11/11/05 P.3)

Thus, Nathan monitored his students' learning mainly through traditional assessment practices. However, his lack of experience in preparing traditional assessment techniques created a dilemma for Nathan. For his final exam, he asked his department head to

provide some example questions. After reviewing these final questions in comparison to his own, Nathan realized he could not construct such useful questions himself.

It is important to note that Nathan did not devote a considerable amount of his time to assess all the assignments and homework that he assigned to his students. During his first year, it often seemed more important for Nathan to invest his time to work on a lecture to make it better rather than working on grading. Thus, most of the time Nathan graded student assignments based on completion. He highlighted,

I have a choice: I can spend those two to three hours per day grading papers or making my lessons better. What do I want to do? Not grade papers. I grade maybe one assignment a week. We had progress reports earlier this week; I was probably the teacher with least number of grades in the entire school. That's fine with me. Not everything they do needs to be graded. (N/09/17/05/ P.2)

Noticeably, Nathan was confident about his decision making on the manner in which he dealt with students work. However, this approach prevented him from developing a full portrait of what his students knew and failed to know. This pattern of decision making prevented him from being able to modify his teaching to better address students' needs. Nathan came to realize these shortcomings of this approach, although he took few steps to remedy his approach to assessment.

Changes in PD for Nathan's Level of Science Content Knowledge

A great portion of Nathan's pedagogical discontentment originated from his lack of content knowledge in Earth Science. During his first year, Nathan was unable to use his classroom time effectively because of his lack of content knowledge in Earth Science. To be an effective teacher Nathan explained "you need content knowledge and I don't know if I have it" (N/11/11/05/ P.1) in Earth Science. During preservice years, Nathan pointed out "you don't know the situation you are gonna find yourself in teaching" (N/11/11/05 P.2). He indicated that his college professors did not mention about this reality during his preservice education. Therefore Nathan noted:

...every lesson plan I ever wrote for my method courses was always a physics lesson, always physics. And that is great, you need to learn how to write lesson plan for your content area. But I wish somebody would have made me write an

earth science lesson plan, because that would be one less lesson that I had to worry about now. And when you've taken all these courses in physics, or if you're a biology teacher, you've taken all these courses in biology, just such experience with the material, the creating lessons isn't a difficult process. But I've never created an inquiry lesson in earth science. And now I have to. (N/11/11/05 P.2)

In his regular classroom time, after taking notes, and class discussion, there was nothing "left" for Nathan to address as the period quickly outstripped his content knowledge. Compared to his student teaching experiences, Nathan indicated that during his student teaching, it was very easy to manage his classroom time with even Chemistry

We go over for the homework for first twenty minutes and they go and take notes for the next forty minutes and so and they take the last twenty-thirty minutes to do homework. But earth science is different because [with] chemistry I can suck time out of a day by just having time for practice problems. (N/12/26/05 P.4)

In terms of reform-based nature of his teaching, it was obvious to Nathan that he was not applying what he learned in his teacher preparation program

...there are times and that is difficult, and you know when I was starting out we did a lot more of, not a lot more but, my, my, I guess I had always envisioned doing a lot more inquiry than I do when I started out. But I don't do as much as I would like. But there are a lot of things. Because of the content, because I don't know earth science well enough to really translate it into inquiry. You know biology to some extent, but not really, but chemistry, and physics I can teach inquiry like that [clicking] with those, those two subjects, because I get them. I don't understand earth science that well. (N/11/11/05 P.3)

Nathan was well aware of his lack of content knowledge in Earth Science and he noted "And it hurts that I am not teaching physics, because I know what I can be, and I know what I am. And those are not the same thing" (N/11/11/05 P.3). The major barrier Nathan saw to his implementation of more reform based practice was that of his limited content knowledge--again a contextual issue.

But earth science there is not that it seems more isolated facts, but I know it is not. ...This is my weakness. It was ten years had passed between the time I took

an earth science and the day I start to teach it. The years I don't remember much. You know and it is hard developing projects for a subject that you don't really know. (N/12/26/05 P.5)

Nathan sometimes perceived that some of the Earth Science topics were irrelevant to what his students needed to know to excel in school or to excel in life. For example, during his second semester Earth Science teaching, as a part of his curriculum he was supposed to teach rock cycle to his students. When his students entered the classroom Nathan asked them to read the section in the book and do the section review on rock cycle. It was how he taught this class. And his students read the section and did the section review and left the class without having any discussions on the unit. After the class we talked about the class, and I asked him why he did not have at least a closing discussion on the unit. Nathan indicated that the content of Earth Science for his fourth periods was very boring and he thought that many topics in fourth block Earth Science were irrelevant and unnecessary. He specified "[the rock cycle] unit doesn't matter" (N/03/01/06 P.12). Nathan explained that rather than spending time for such units he prefers to discuss social and political issues that his students are familiar within their daily lives. Nathan noted:

I would rather to spend much more time looking at why didn't the US sign the Kyoto Protocol as opposed to like "Oh this one the, the something rock turns in that rock through this process." Ok, that is lovely. Sorry we missed the really good learning experience talking about rocks instead. And less is more. What we need to do is we need to strip those books down. (N/03/01/06 P.12)

I reminded him of the possibilities that student might gain from this unit. He responded saying that not only did he not want to spend time in understanding Earth Science; Nathan also knew that when he decided to teach these units effectively, he needed to plan and utilize classroom activities and labs. These activities would require Nathan to plan and generate new lessons. Nathan was concerned about available materials for Earth Science. However, there were many resources including "box curricula" (i.e., GEMS, FOSS) available to Nathan. But Nathan argued that he did not have time to become familiar with and use these resources.

Nathan indicated that in Physics, it was very easy for him to recognize the effectiveness of his teaching because he had a better understanding of Physics and he could ensure his students' learning in Physics. He noted "I can give you an equation, you can put that into a sentence [and] you probably know what you're talking about" (N/12/26/05 P.3). On the other hand, Nathan explained that he did not have this content background in Earth Science, and because he did not have time to enhance his Earth Science knowledge during his first semester at Kent High School, Nathan believed that his teaching was not effective

Nathan's Final Beliefs

This section focuses on Nathan's beliefs at the end of the school year. An investigation of Nathan's final beliefs about teaching science revealed a significant difference to those he brought into the school year.

Nathan's Final Beliefs about Science

Nathan's beliefs about science remained constant through his induction year. According to Nathan, science consisted of natural explanations which were "some sort of...regular occurrence, obeying laws whether or not we know or understand those laws you know it should obey natural laws for observable phenomenon" (N/06/23/06 P.2). And based on his definition, which nurtured by one of his master's classes, Nathan argued that we need to teach science as a body of knowledge where science interacts with all other knowledge basis. According to his definition, teaching science that was disconnected from other bodies of knowledge was a sort of disservice to science. To identify the interrelated nature between science and other subjects, Nathan noted,

...science is a human endeavor and so what mistakes are made by human in the name of science, what connections does science have to music, art or even math or history. So, I think that's important, which is why I wanted...I do a lot of that. You know when we're talking about the science I bring in the historical context. You know why was it that? It was Newton and not Aristotle that came up with universal gravitations. Or what was it about the historical context Newton was operating in that allowed him to do what he did? (N/06/23/06 P.2)

On the other hand, Nathan came to understand that in current science education many science teachers do not address the connections among different science subjects.

To understand the energy we talk about in terms of biological life energy “Why do we eat?” “Because we need energy to run around and procreate and do whatever else we do.” And the energy we talked about in physics in terms of energy transformations are the same energy. You know biological energy and physics energy are both energies you know and you know we don’t talk about...But very rarely do we help our students understand that from a chemistry point of view or physics point of view. (N/06/23/06 P.2)

Ironically, Nathan was not able to convey this understanding of science through his teaching.

Nathan’s experiences relevant to NOS mainly revolved around specific, ever lasting, contradictory issues. As opposed to his early attempts to facilitate a limited NOS unit emphasizing “predict, observe and explain” in his teaching, by the end of the school he focused largely on the intersection of science and religion. Because of his first year experiences, especially in his Astronomy class, Nathan came to realize that teachers needed to provide students with a point of view that science and religion did not contradict with each other. Nathan worked to restructure a new role as a science teacher for himself. His goal became, not to “bastardize” science or religion, merging them together; he wanted his students to understand that the two ways of knowing could co-exist separately. Nathan indicated that his goal was to show students that they didn’t have to select one or the other way of knowing, rather to “allow them to have both of their disposals.” (N/06/09/06 P.1)

Markedly, Nathan’s lack of emphasis on enhancing his students’ understanding of NOS lead Nathan focus on providing students as set path to mitigate between the two. In contrast, during his preservice education, Nathan understood that to overcome such contradictions in science classrooms, the primary role of science teachers was to equip their students with a profound understanding of NOS, which would also play a significant role in helping students to assume new roles as learners in reform-based science classes. However, at the center of his first-year teaching, much of the activity basis for NOS

instruction was lost. Instead, Nathan distilled the content of NOS and attempted to present it in a direct, didactic fashion.

Nathan's Final Beliefs about Science Education Reform

One of the most notable changes in Nathan's belief system revolved around the idea of reform in science education. After his first year, Nathan came to realize that his naïve and idealistic perception about the science education reforms provided scant assistance in changing in his students' lives in Kent High School.

Nathan left his first-year teaching with a belief that the current approaches to an equitable science education as described in the reforms actually presented a disservice for some of the students in the school system. Nathan found it naïve to "prepare every student in a manner as if they will go to college" (N/06/23/06 P.7). Nathan found it virtually impossible to provide his students with a science experience in which "we don't want one size fits all science education" (N/06/23/06 P.7). He found himself incapable of adjusting to meet the needs and strengths of particular students, and equity became an unachievable goal.

Unlike his beliefs about reform in science education that he held at the beginning of his teaching, he understood that it was impossible for an individual beginning teacher to challenge the educational system. Nathan explained,

...you can't just be like a rogue in your school. You're part of the school environment and so I used to be able to answer that...be aware of reform in inquiry and blah, blah, blah. Yeah, that's important but you need to be aware of so much more. You need to be aware of what your administration is gonna expect.

(N/06/09/06 P.1)

Consequently, Nathan noted that being aware of reform was crucial for a teacher, but the practice of reform-based instruction must be highly dependent on the political and administrative context of the school.

As far as Nathan's beliefs about reform in science education, Nathan realized that a systemic change in education was necessary to make reform suggestions as constant facets for teachers' everyday practices. In order to have a systemic change and implement reform implications in science education, Nathan explained that entire science education

community should work cooperatively, which was something that Kent High School did not underscore.

In order to support beginning teachers, Nathan argued that teacher education programs could best help beginning teachers to keep their idealism alive and practice what they know to be effective in science teaching if they were to temper this enthusiasm during the preservice programs. He described that novices needed to better understand bureaucratic structure of a school in order to have any hope to be able to act effectively within this system. Nathan noted,

...just to understand the dynamic of the school. You know you're concentrating on the teaching but that's not all that's going on and maybe one day you just ask...you know sit up in the main office and spend an hour in the office to see how things go down there. You know spend an hour in the media center or you know just look at the interactions between all the players in the school.

(N/06/23/06 P.7)

Similar to his first year beliefs about the state achievement testing, Nathan also repeated that he felt shortchanged with the message that his teacher education program delivered to him. He argued that his preservice program's stance on achievement tests fostered much of his struggle during his first year in Kent High School. By the end of the year, Nathan came to understand that although there were some real concerns for the state testing, there were also some benefits of the test. He explained:

I think there are some good things about [the test]. At least yes we are responsible for learning. You know where before you might have been able to just give up on kids, at least now, regardless of whether we think it delivers meaningful learning it prevents a school just saying "This group of kids, we're not gonna care about them." You know that is a big thing especially in Science for all Americans. And that is an advantage and that something that [the test] does well. It requires us to value educational outcomes for every student. Yes, we have legitimate concern with [the test] and there are benefits to [the test]. (N/06/23/06 P.13)

Thus, to better assist first-year teachers, Nathan suggested that the teacher education institutions should underscore and inform their candidates about the state achievement test as a crucial reality of today's schools. Moreover, rather than focusing

how the achievement tests were not compatible with reform suggestions, the teacher education institutions should empower preservice teachers to teach for effective science through reform within the context of accountability.

Nathan's Final Beliefs about Science Teaching

The change in Nathan's beliefs about science teaching was quite explicit by the end of the school year. Based on his first year in teaching, Nathan realized that teaching was very complicated and to be an effective science teacher, there were so many variables for every student, for every class, for teachers to take into account. Nathan stressed "...you need to be aware of almost everything at once and be able to make snap judgments" (N/06/09/06 P.1). Indeed, the biggest impact on his belief change was originated from his growing recognition of the importance of contextual factors. The contextual contradictions embedded in Kent High School lead Nathan to adjust his beliefs about science teaching and his teaching practices toward those that were more traditional.

In order to teach science effectively, Nathan came to an understanding that teachers need to be aware of the contextual realities and teach through reform with a consideration of their specific student population's needs. "Some students are more able to handle inquiry than others. You get a group that is less able to handle inquiry, and then you need to tone it down" (N/06/09/06 P.1). Yet, Nathan also thought that it was no easy task to know the necessary skills for effective science teaching, and it was not simple to teach science effectively because "there are so many complexities, because education is not just about educating anymore." (N/06/09/06 P.1)

By the year's end, Nathan identified the most crucial requirements for effective science teaching as supportive administration and motivated students. Besides these facets, he also explained that beginning science teachers should be provided with a lighter teaching schedule and more freedom to evaluate what they brought into teaching.

Nathan also became more aware of the significance of teacher candidates' content knowledge of different subjects. Nathan argued that it would have been more effective if his program required its preservice teachers to focus on and prepare themselves for teaching different subject areas than those for which they majored. Nathan thought it was

the program's responsibility to help preservice teachers to become competent in several disciplines, to better prepare them for the rough and tumble of schools.

In spite of his lack of attempts to teach science through inquiry during his first year in teaching, Nathan's perception about inquiry-based teaching also changed during the course of his first year in teaching. By the end of his first year, Nathan found that the manner in which his teacher preparation program exposed inquiry to them was limited. Although he began the year explaining that his preservice education provided him with various different teaching methods along with the practical and theoretical underpinnings of current science education, he left his first year with a belief that his teacher education program introduced inquiry as the sole and most effective way of science teaching. In retrospect, his vision of his preparation narrowed, and within this narrowing Nathan found room to reject much of its underpinnings.

By the end of his first year, Nathan asserted that work sheets, lectures, reading assignments, and videos were also crucial methods for effective teaching. Ironically, Nathan combined the intensely practical with the very theoretical as well: "Our students need to be equipped with all the tools because they're gonna be confronted with situations that require a scientific guidance. They're gonna be confronted with the other situations that require morality" (N/06/09/06 PP.1-2). Here *morality* referred to a set of thoughts based on religious perception. Although use of various different teaching strategies had nothing to do with moral education, Nathan implied that the sole focus on inquiry-based science teaching and reform implementations hindered future science teachers' ability to deal with other possible sets of contradictions embedded in actual teaching context.

For Nathan, students of preservice science education were somehow different and special because of their desire to teach science. Although they could easily be scientists and find good paying jobs, they became science teachers because of their desires. Thus preservice education should "inspire" them to be "not good science teachers" but "great science teachers." Nathan saw this as possible through equipping them with social, moral and practical aspects of teaching (N/06/23/06 P.9).

Nathan Final Beliefs about Student Learning

By the end of his first year, Nathan came to an understanding that the anatomy of student learning was a very complex and a product of a number of influential factors. Within the context of students' learning, similar to his midterm belief, Nathan identified many important "players" in school--- teachers, administrators, parents, other students, each with their prior learning and science experiences, and each with different expectations of school and life.

Additionally, his final belief about student learning was that teachers were accountable to their students, and students demanded things from their teachers, and sometimes these demands were not in the students' interest. Nathan came to realize that it was a disservice to students to not to "give" them what they want. It was a disservice to teach them via an unfamiliar approach. Thus, he believed that when teachers did not teach the way the students expected, then the students would put up oppositions to the learning experience. Nathan specified that he did not necessarily support traditional teaching; however, he explained, "...systemically we create that expectation. And you have to direct your efforts correctly" (N/06/09/06 P.3.). Consequently, as opposed to his initial first year beliefs, for Nathan it was reasonable and beneficial for teachers to teach science through traditional ways of teaching when these traditional teaching approaches were the predominant teaching approaches in the school context. In Nathan's final beliefs, we see an assimilation or internalization of the norms of the community and a rejection of the norms from his preservice experience.

Nathan's Final Self-Efficacy

The end of the school year allowed for a celebration of Nathan's professional survival. In addition to his first-year teaching responsibilities, Nathan also pursued his graduate coursework and began preparation for his master's thesis. This balance between teaching and graduate education always created a time constraint, which heavily impacted Nathan's performance as a first-year teacher. Nathan sometimes felt as though he had to make a choice between paths. At those times, Nathan considered withdrawing from teaching profession and pursuing a graduate degree in educational leadership or

history of philosophy of science. With the rigors of the first year, the more academic route seemed the more attractive of the two.

Looking back, Nathan saw the only things that kept him bound to his profession was his passion toward teaching and his self-confidence. Nathan clearly understood why many teachers leave the teaching profession in their early years in service. He explained that if another first-year teacher was faced with the challenges that he had, she/he would quit teaching immediately. Thus, Nathan looked back at his first year with confidence. He explained that his efforts to overcome his many obstacles only served to strengthen his self-confidence. By the end of the school year he saw himself as “a stronger teacher.” (NM 06/09/06 P.2)

Nathan’s teaching self-efficacy remained at years end. He did not seek instructional help or suggestions from his department faculty, and only made himself open to instruction on the “technicalities of school,” such as reporting grades, and reports.

Indeed, Nathan recognized that he was “pretty confident with [his] teaching and he identified himself as “pretty self-sufficient.” (NM 06/09/06 P.3)

Although he also believed that watching other experienced science teachers would help him to learn more about classroom management, even looking back at the year, Nathan “didn’t think of it as necessary” (NM 06/09/06 P.2). The other experienced teachers all had “high level,” motivated students very different from those in his classroom.

Nathan’s Final Teaching Self-Efficacy

The detailed examination of Nathan’s final personal teaching efficacy and outcome expectancy revealed that Nathan envisioned himself to be a more competent science teacher because of the experiences that he gained at Kent High School at the end of his first year in teaching. By years end, Nathan had largely come “full circle” in his teaching self-efficacy

Interaction between Nathan’s Final Self-Efficacy and Content Knowledge

As discussed earlier, Nathan’s lack of content knowledge appeared to be one of the most influential facets of his teaching self-efficacy his first year. Nathan indicated that because of his challenging experiences in teaching Earth Science, he gained a better

understanding of science concepts and the interrelations of Earth Science content with other science disciplines. Based on this deeper understanding, he envisioned himself facilitating more student-centered teaching style during the following year.

Interaction between Nathan's Final Self-Efficacy and Pedagogical Knowledge

Leaving his first year, Nathan understood that he had the necessary skills and knowledge to teach science, and he felt more competent to “turn students on” to science in the following year. Because of his sense of care about his students, he argued that despite of his ineffective experiences in teaching, there were a lot of teachers out there who were not as effective as he was, and for Nathan there were “no better ones” (N/06/15/06 P.2).

Before he started his first year, teaching was a passion for Nathan, and he was very enthusiastic about teaching science. However, Nathan lost his passion and his enthusiasm quickly and he even began to dread his work. His first year allowed him to see that teaching was difficult and complex, much more so than he ever expected. Nathan saw that his idealistic teaching goals became more realistic during his induction year and he realized that “I’m not gonna save the world every day” (N/06/09/06 P.2). But he did envisioned himself as continuing to learn about different, more effective teaching approaches.

Nathan's Final Outcome Expectancy

As far as Nathan's outcome expectancy about students' achievement in science, Nathan changed his perception about the contextual factors influencing students' achievement in science. By mid-year, Nathan had come to see teachers playing a very minimal role in their students' learning. He saw learning as more highly influenced by aspects of the teaching context and students' motivation. But by year's end, Nathan regained his early outcome expectancy, and again explained students' achievement as directly related to a teacher's effectiveness. Even with low performing students or students who lacked motivation toward science learning, Nathan understood that the inadequacy of a student's science background could be overcome by effective teaching.

That said, at the end of his first year Nathan understood that there were multiple factors that held a significant amount of influence in molding students' achievement in

science classes. In his final perception, teachers were not the only group of people who were responsible factor for students' achievement. He came to understand that for effective science teaching and learning, science teachers needed to consider interplays of multiple contextual factors that influence students' achievement.

Based on his first year experiences, Nathan's perception about the achievement of certain groups of students remained the same as discussed mid-year. He understood there to be students that have "no interest" in science or in schooling. He believed that problems of these students originated outside the school context. Thus, for these students, he believed that school-parent collaboration was necessary. According to Nathan, teachers' increased efforts in science teaching held little promise to produce change in such students' achievement in entire schooling unless there was cooperation between teachers and parents.

Nathan's Final Pedagogical Discontentment

Similar to his initial and midterm experiences, we see that Nathan continued to experience very little pedagogical discontentment. As was seen throughout the year, Nathan left his first-year teaching with an understanding that the contextual factors embedded in his teaching context were the chief factors for his ineffective first year experiences at the end of the school year. Thus, he experienced a vast degree of contextual discontentment, for the most part avoiding any pedagogical discontentment.

Final PD for Teaching Inquiry-Based Science

Clearly, Nathan did not typically employ a student-centered, inquiry-based teaching style. However, on the infrequent occasions when he designed activities for his students, he realized that his students quickly became engaged and interested. Nathan recognized that there was some success in those activity-based lessons. Because of this promise, Nathan envisioned activity-based science lessons as the most concrete part of his teaching context for his future years in teaching.

Nathan primarily blamed unsupportive school administration and school community as well as his students' low academic level for his failure to achieve his teaching goals. However, the school community, especially some teachers in science department, offered Nathan their support. Nathan, however, was reluctant to accept their

help because of his identity as a self-sufficient teacher. Although he typically blamed contextual factors as preventing him from being the teacher that he was able to be, by the end of the school year Nathan came to a partial realization that there were also individual factors preventing him to achieve his teaching goals too. Nathan explained “I don’t necessarily...regret isn’t the right word [but] I could have been better” (N/06/09/06 P.1). And he noted

I got started on such a terrible foot. I was not a good science teacher. Maybe I was a good science teacher but I wasn’t the science teacher I’m capable of. And that pains me too. I’m so much better than what I allowed myself to become.
(N/06/09/06 P.1)

Final PD for Teaching across All Student Ability-Levels

Nathan initially thought that he could make a difference at Kent High School and that was the biggest motivation for him to select this school for his first year. Before the school year, he envisioned himself as teaching honors, upper level students. He felt confident that he could “get them excited” about science. After his first exposure to teaching, he realized that his students were not “smart kids,” thus he noted “I can’t teach lower level kids, but I know in my just daily vocabulary things that I say will go over their head and you know some of the subtleties of what I’m saying is kinda missed” (N/06/23/06 P.5). Nathan understood the student population that he taught summed to be was the major, determining factor in its ineffectiveness. Again, we see contextual discontentment trumping any sense of pedagogical discontentment.

As far as Nathan’s pedagogical discontentment in teaching science to students across all ability levels, similar to his initial first year perception, Nathan explained “...it is more natural for me to teach the upper level kids because my natural discourse is more in line with what they can understand.” Therefore he indicated “developmentally I’m better with the more [cognitively] developed students.” (N/06/15/06 P.7) Nathan explained that he did not try to help these unmotivated students and although he felt “bad about those kids,” Nathan indicated that he did not have enough time to make “a change in their life” since he invested most of his time for his graduate studies (N/06/15/06 P.7).

The small amount of pedagogical discontentment he experienced in this facet of his teaching was not enough to invoke action on his part.

Nathan left his first-year of teaching with an unresolved question about the role of school for his low level students with lack of motivation to learn within the system. He stated

Why are those kids in school? What is school supposed to give them? Is it fair for school to approach schooling as everybody should be prepared to go to college even though we know that that's not gonna happen? Or should school provide them with job skills? Or, or, what? You know so, why am I teaching these kids? And that's the question that was very...the answer to that question was ambiguous. (N/06/15/06 P.7)

Final PD for Resolving Depth vs. Breadth Content Issues

In terms of Nathan's attempts in resolving content issues revolving around depth versus breadth of coverage, Nathan recognized that he did not teach Earth Science the way he would have liked. Although he knew that there were better ways to teach Earth Science content, again he recognized contextual aspects as the barrier to his teaching goals. He indicated that he taught his Earth Science classes through a didactic, lecture-oriented approach, covering a large amount of material but failing to engender deep student learning. He saw this failure to achieve an adequate balance as the fault of his limited content knowledge in Earth Science, again a contextual issue that was due simply to him being required to teach "out of field."

Final PD for Assessing Student Learning

Following the pattern discussed previously, Nathan realized that he did not adequately assess his students' understanding, but this failure was due to aspects of his teaching context. He came to realize that the context of his teaching and today's school in general made "meaningful assessment" difficult. In terms of his definition of meaningful assessment, Nathan believed "Assessment is theoretically a guide ...to some extent assessments [are] to guide your next step" (N/06/09/06 P.2). Ironically, as opposed to his beliefs, Nathan's first-year activity system did not exhibit any application of meaningful assessment techniques. Rather, as far as his assessment, Nathan heavily relied on

traditional assessment techniques. And most of these techniques were employed more for student grading or classroom management rather than as a monitor of his students' understanding or a guide to future teaching. He noted "what I do is I hand them a work sheet, I collect it. If I've got time I grade it if it's right or wrong then I hand it back. And then they take a test." (N/06/09/06 P.3)

However, Nathan's reflection on his first year experiences helped him to understand that it was necessary for him to improve his assessment techniques. Before his next year started, Nathan planned to prepare effective lesson plans and structure a new guideline for his assessment. Although he was able to recognize his limited use of alternative assessment techniques, it seemed that his pedagogical discontentment in monitoring his effectiveness and his students' science learning his recognition of his limitations were overshadowed by his emphasis of contextual barriers that shaped his teaching.

Final PD for Nathan's Level of Science Content Knowledge

Nathan explained that in spite of his overall didactic and lecture-based instruction, there were some activities and classes that Nathan considered effective and satisfying. In Earth Science, Nathan specified that the classes that he enjoyed were mainly activity based and that these classes dealt with the concepts that Nathan fully understood, such as density. In spite of his partial improvement in understanding of Earth Science content, Nathan did not feel competent enough with Earth Science to generate effective learning experience for his students. And if he were to teach Earth Science at Kent High School for the next year, he explained

I was teaching earth science again next year I would have...this summer I would have set down with Mr. McClain a few times and really hammered out stuff, you know really looked through his materials and sit there with him for like two-three days doing all the labs. (N/06/15/06 P.5)

Evidently, by the end of his first year Nathan came to a pedagogical discontentment of his lack of content knowledge. During his first year, Nathan always brought his lack of content knowledge in Earth Science as a reasonable excuse for his ineffective first-year teaching. By the end of his first year, he became more critical about his lack of attempts

to learn the content and gave voice to pursuing a resolution to this issue if his teaching context required him to teach Earth Science again.

Summary

This chapter illustrated that Nathan's internalization of his first-year activity system challenged his preservice perceptions and beliefs about teaching science. Although Nathan started his first-year teaching as a reform-minded first-year teacher whose primary purpose was to inspire his students with a global understanding of science through enactment of science education reform, Nathan's beliefs about teaching and learning as well as his first-year activity system goals changed dramatically.

As far as the changes in his beliefs, Nathan understood that systemic change in science education was not a simple task for beginning science teachers. He understood that student motivation and collaborative work to overcome contextual contractions were necessary to provide effective and equitable science learning experiences for all students.

Nathan's high personal science teaching-efficacy did not change during his first year at Kent High School. Because of his strong pedagogical and content knowledge background from his preservice period, Nathan's high science teaching efficacy remained intact. On the other hand, overwhelming contradictions resulted in dramatic changes in his outcome expectancy. During his early days in his first year, Nathan believed that he was the individual most responsible for his students' science learning. By the midterm, Nathan came to understand that there were many other influential factors influencing students' science learning. He understood that student motivation, parental involvement, constant emotional and professional support for teachers were some of the most important requirements for students' higher achievement in science. In spite of his internalization of these, Nathan was not able to address these contradictions since he understood them as overwhelmingly contextual in nature and beyond his reach.

Nathan's first-year activity system illustrated that Nathan mainly relied on teacher-centered, lecture-based teaching practices. Thus, his first-year teaching practices were not compatible with science education reform. Not surprisingly, Nathan did not critically reflect on his teaching to explore possible mismatch between his teaching goals and his actual first year science teaching. It was because of his understanding of

contradictions embedded in his first-year activity system as solely context-dependent that Nathan's ineffective science teaching practices remained unquestioned. He continued to recognize the context of his first-year activity system as responsible for his ineffective, traditional science teaching practices.

Engeström (1987) argues that novices' learning is a long-term process of internalization and externalization, including the appropriation of available cultural resources and design of a novel form of practice. Nathan, in his quest to become a competent teacher, struggled to overcome and address contextual contradictions of his first-year activity system. Because of his overwhelming emphasis on his first-year teaching context, Nathan was not able to focus on his role in his teaching. Because of the interaction of his self-sufficient identity and the individualistic nature of the school context, Nathan's limited participation in communities of practice of Kent High School restricted his attempts to address these contradictions and focus more on his teaching practices (Roth, 2002; Roth & Tobin, 2002).

This chapter provided an analysis of Nathan's beliefs, self-efficacy and pedagogical discontentment and how these changed and Interacted with his teaching practices. The following chapter explores the factors in Nathan's first-year activity system that caused these changes.

CHAPTER 5

THE ACTIVITY SYSTEM FOR THE IDEALIST

In CHAT, every activity is undertaken by a subject who is motivated toward the solution of a problem or object, and mediated by artifacts in collaboration with others community members. The structure of the activity is constrained by cultural factors, including rules and division of labor within the activity system (Engestrom, 1999).

Chapter 4 included an analysis of Nathan's beliefs associated with science and science teaching, focusing on how these beliefs changed over his first year of teaching and the manner in which these beliefs shaped his teaching practices. The purpose of this chapter is to describe the components of Nathan's first-year activity system and how these components interacted to shape his first year at Kent High School. **Table 5-1** describes the various components of Nathan's first-year activity system. This chapter explores Nathan's first-year activity system through the trajectory of CHAT.

Finally, I offer a description of the interrelated relationships between individual and contextual factors shaping Nathan's first-year experiences mindful of enactment of science education reform.

Table 5.1: Synopsis of components of Nathan's first-year activity system

Personal Teaching	-Self-Sufficient
Identity	-Friend to students
	-Close to Learn
Identity expected of	-Non participatory
Beginning Teachers	-Traditional apprenticeship

Table 5.1: Continued

School	Institutional Description	Goals/Objects	Community
Kent High School	60% Minority	Fulfilling yearly progress	Conform
	40% White	requirements	Be conventional
	41% Free or Reduced Lunch	Increasing student	Community of practice
	Low socio-economic background	achievement	limited to -personal and
	Urban public high school		departmental attempts
	Low achieving D School		Administrative power
	Low School Capital		Pedagogy of Poverty generating low emotional energy
Support for	Mentor Teacher		
Beginning Teachers	First Year Teacher Consular		
	Unofficial support from other teachers		
Subject	First Semester	Second Semester	
Taught/Work Load	3 9 th Grade Earth Science (Out of Field) No extracurricular responsibility	-2 9 th Grade Earth Science (Out of Field -An elective Astronomy (mixed student grade levels, mainly seniors) No extracurricular responsibility	
Classroom Context	Non generative, limited interaction Limited physical space with lack of supplies for activities		

Subject

In its simplest terms, Ryder (1998) defines activity as the engagement of a subject toward a certain goal or objective. The purpose of the following section is to better understand how Nathan's identity and emotions interacted and molded his first-year experiences.

Identity

In an attempt to understand first-year science teachers' experiences many researchers examine how personal and professional identities of novice science teachers interact in shaping their early experiences in science teaching (Abell, 2000; Danielewicz, 2001; Volkmann & Anderson, 1998). Research in science education has shown that school contexts and subject matter specialty influence a teacher's science teaching

practices and personal identity (Brickhouse & Potter, 2001; Helms, 1998; Wenger, 1998) and how identity, in turn, shapes science teachers practices (Olitsky, 2005, 2006)

To understand the depth and severity of the difficulties Nathan experienced during his first year, I chose to focus on his identity. During the year I spent with Nathan, it became clear that his own identity as a teacher and as an individual played a significant role in shaping his actions within his activity system including individual, social, and institutional influences/forces (Carlone & Webb, 2006). The contradictions among these various different levels played a significant role in molding his first-year experiences, from his broader first-year activity context to his specific classroom context. Nathan performed different identities for his students and for administrators and other students. At the center of his first-year activity system, while Nathan exhibited a self-sufficient identity as his professional identity when he communicated with the school administration and other teachers, he attempted to enact a familiar identity with his students--working for them to accept him as a friend and as their champion.

As I came to focus on Nathan's professional identities, I came to recognize the close relationship between Nathan's emotional states and the way in which his identity was accepted within different social groups (i.e., teachers, administrators, students). Given that Nathan's identity formation and his emotional states were closely intertwined, it became necessary to explore Nathan's emotions and explore how they influenced and were influenced by Nathan's first-year experiences (Zembylas, 2004)

Nathan was a self-sufficient and idealistic teacher who liked to express his thoughts openly in any settings. During his student teaching period and during his preservice experience he enacted a competent, student focused, reform-minded identity--he worked to position himself as someone who championed the cause of students and worked outside of the "system" to help students achieve. During this time, his identity was well received in his different systems--the school and the university. Indeed, during his preservice years, external validation and positive recognition appeared to be a crucial source of motivation for Nathan. Similarly, Nathan's identity formation revealed that external validation of his own self and practices as well as positive recognition remained crucial for Nathan during his first year.

Nathan started his first year with a mind set that his participation in the Kent High School community was an opportunity for him put his ideals into practice. His identity that he enacted in these first weeks of teaching was a self-sufficient, competent, nontraditional, student champion. His early time at Kent High School convinced him that he could make a difference there; he saw himself becoming a crucial member of this community.

During his early days in Kent High School, Nathan worked to maintain an identity that was relatively different than the traditional teacher portrait. He believed that his preservice education as well as his master's studies provided him with an exceptional theoretical background of how knowledge is learned and his exposure to "learning theories," "inquiry" and "conceptual ecology" made him a more informed, knowledgeable, and capable teacher. His understanding that his youth was not a barrier to success carried with it high expectations of all his students.

In performing this "rebel" identity, Nathan openly expressed his opinions about the school policies at faculty meetings--believing that the administration hired him for his insights. However, he quickly came to understand that the school community recognized Nathan only as a novice--one who should remain silent and carry out the school rules and values. The portraits of the appropriate actions for a first-year teacher were in stark contrast to Nathan's professional identity.

It was interesting to see that Nathan worked not to assimilate himself into the culture of the school; rather he worked to maintain his own professional teaching identity--competent, non-traditional, champion of the student. In Nathan's view, the administrators and teachers simply failed to realize his abilities and were so tied to the status quo that they could not accept his contributions. Thus, this contradiction between Nathan's professional identity and the teachers/administrators' expectations caused Nathan to isolate himself from other adults. This early contradiction played a crucial role in preventing him from socializing with other teachers, and worked with his already high self-efficacy to further limit his openness to assistance and support.

Soon after Nathan realized that his own professional identity was not supported by the teachers and administrators in this school, he turned to his students for positive realization and external validation. Through his attempts to structure a strong sense of

student rapport, Nathan worked to perform this student-focused, champion identity. Indeed, during the emotional beginning of the year when Nathan failed to get affirmation of his professional identity from his colleagues and supervisors, his rapport with his students became all the more important. Since he was a young teacher and his students were comfortable talking with him, he explained “They like coming to my class. I make them believe in themselves” (N/09/17/05/ P.5). Nathan also stressed that his students were aware of his feelings about them. He indicated “I care [about them] and they know that I care. They see it in my face” (N/09/17/05/ P.5). Nathan noted “On my free time I hang out with my students. I don’t hang out with other teachers.” To maintain his good rapport with his students, during his first semester at Kent High School, he participated in his students activities and went to “their games and support them” (N/12/26/05 P.1). Nathan noted:

...they come to me. I have a group of like 10 students come to eat lunch in my room because they do, they hanging out in my room. You know I talk around with my students, I ask them how their personal lives are. They give me pictures. You know that goes such a long way. (N/09/17/05/ P.5)

Nathan put a great deal of effort in performing this student centered identity--in maintaining his rapport. Indeed, as the school year progressed, his professional identity could best be characterized as “friend to the student.” Because of this importance, Nathan spent more of his time maintaining rapport and student communication than focusing on his teaching of science. Nathan’s teacher identity was a friend to his students rather than a science teacher who solely teaches Earth Science. For example, he advised his male students on their relationships with their girl friends. He constantly encouraged his students to share their personal problems with him and his students were comfortable talking to him about their private problems. It eventually became his role to listen to his students’ problems and advise them as “an ally, as somebody to come for advice, somebody who’s been their struggles.” (N/02/03/06 P.15)

Thus he became popular among the Kent High School students because of his friend to the student identity. For example, in his second semester in Kent High School, his Astronomy class was very popular among the students. At the beginning of the semester, twenty two students enrolled in his class. His student population increased to

thirty three by the end of the semester. Nathan explained “Students flocked to me. They want to be in my class. Not because they want to take science, because they wanna be in my class” (N/02/03/06 P.16). Evidently his relaxed classroom culture appeared to be compelling for the students, and their positive reactions were very motivational for Nathan supporting this friend to the student identity.

As a return for his strong sense of care toward his students, Nathan gained a strong sense of loyalty from his students, providing a source of external validation and positive student recognition. His students’ strong sense of loyalty toward him was apparent during one of the school administrators’ observation for his class. While Nathan often had management problems during teaching, when an administrator came to the class for an observation, the students behaved flawlessly. In Nathan’s view this was another point of evidence that his students valued him: they were loyal to him and sought to protect him from his superiors.

This, too, reinforced Nathan’s view of himself as more aligned with the students than with the administrator. For Nathan, the “us versus them” was the students and him against the other adults in the school. Nathan understood “them” to include other teachers in the school. While student may look upon other teachers as “old and they’re just pissed off,” (N/02/03/06 P.1) he explained “[students] realize that I’m on their side” that meant that he was there to “make their life better” (N/02/03/06 P.8). Other teachers were there to make the student life “a pain, make it harder and make it more difficult” (N/02/03/06 P.8). Nathan explained:

Out of any teacher at that school I have more student loyalty than any other teacher. The other teachers, they’re upset that I walk into that school and have rapport, unbelievable rapport not only with my students but with their students. (N/02/03/06 P.1)

Because of this sense of student loyalty toward him, Nathan believed that the school administration was worried about student reactions if they fired him. Nathan expressed that no other teacher had the same rapport with students that he enjoyed. Therefore Nathan stressed that because he cared about his students more than any other teachers at Kent High School, he was an exceptional teacher at this school.

I think my personality is more important than how good of a teacher I am. I can be the worst teacher but because my kids like me because they feel safe in my class, because they think that you know I'm working for them as opposed to against them. (N/02/17/06 P.4)

Indeed, his student rapport appeared to be more important than his "actual ability as a teacher" during his first year. (N/02/17/06 P.4) Ironically Nathan's identity as a friend for his students prevented him from facilitating his classroom rules. Along with his lack of classroom management, his ineffective teaching also worked to make Nathan emphasize his identity as a friend for his students. In his first year, Nathan spent most of his out of class time with his students talking about their social lives. Because of his lack of preparation, class time was often wasted, and after the most rudimentary material was "gotten through," the remaining classroom time became an opportunity for Nathan to talk with his students about lives.

Not surprisingly, Nathan's individual identity as a self-sufficient, competent, nontraditional student centered, student champion was not recognized by his colleagues or administrators. Too, eventually, even some of his students failed to recognize Nathan in this identity. Thus, these contradictions created emotional disputes for Nathan, disputes that influenced many other aspects of his activity system.

Emotion, Identity and Work

Zembylas (2004) argues that emotions are more than the product of individual personalities and experiences; rather they are constitutive of social settings that comprise interpersonal relationships of power and control in institutional settings. Thus, emotions shape learning and teaching experiences for both teachers and students (Zembylas, 2004). The role of emotions is to mediate one's efforts to develop appropriate competencies into an activity system through individuals' social interdependence, which Mahn and John-Steiner (2002) define as human connection and caring support within an activity system.

Similarly, in CHAT, Roth and Lee (in press) provide a profound description of how emotions shape an individual's learning. According to their assertion, and also confirmed by Collins (2004) and Olitsky (2006), positive emotional energy may increase one's possibilities in the world. Although the subject of an activity system experiences

many successes and failures in their participation of an activity system, the possibility of success shapes the way in which the subject engages in activity. The subjects' successful participation in an activity enhances the transformation of the subject into a competent member of the activity system through the subject's enhance participation (Collins, 2004; Mahn & John-Steiner, 2002; Olitsky, 2006; Roth and Lee, in press). Although these authors do not focus specifically on negative emotions and their influence, conceivably an existing negative emotional state may also influence the subject's selection of actions as well, serving to transform the subjects participation--dampening their participation or causing them to seek an activity system that they can be competent within (Collins, 2004; Olitsky, 2006.)

As mentioned earlier, Nathan started with his first-year teaching with a self-sufficient, competent, student centered identity--seeing himself as a teacher who cared deeply about students. To act on this care, he was willing to take risks, to rebel in this school that has a history of underachievement of its diverse, low SES population. Thus, Nathan was willing to teach at Kent High School to make changes, and he wanted to "fight their fights." (N/06/09/06 P.2)

Nathan entered his first year understanding it to consist of a fight for "freeing" the entire school from its historical position of underachievement. Based on his student teaching experiences here, he expected a very supportive administration. However, Nathan described a series of tensions growing between him and the school administration beginning with his first days at the school. In the third week of Nathan's employment, the school administration during a general faculty meeting asked teachers for their inputs concerning a new curricular implementation. The new policy that the school administration intended to implement was to schedule 10 minutes math "warm up" every day in each class to strengthen the students' math ability--with the goal of increasing student achievement scores in state's achievement test.

Not surprisingly given his performed identity, during the meeting Nathan expressed his thoughts about the implementation. Acting as one who wanted to contribute the decision making process as one of the teachers of Kent High School, and given his history of others valuing his ideas, he voiced a very critical assessment of the administrations' proposal. He said "Our students are becoming frustrated with this [rote

material]. They are tired of being handed this implicit message of inadequacy” (N/11/18/05 P.2). The reaction of the administration to Nathan was very intense and harsh. He noted “...we went to this meeting and I poured my heart up to my administrator and I was essentially told not to come back next year.” (N/11/18/05 P.1).

Thus, in the early weeks as a professional, Nathan’s high energy and positive emotions related to this identity was questioned by school administrators--with their recognition of him as “first-year teacher” with little to contribute to a useful conversation of schooling. Thus, Nathan was confronted with one of the most dramatic contradiction that could happen to a beginning teacher. After this interaction, Nathan went to school every day for a month thinking “Maybe I am gonna lose my job.” (N/11/18/05 P.1)

This extreme contradiction elicited an emotional dispute for Nathan that he “will never forget.” This event was significant to Nathan, and he came to understand that “[the school administration] was there to make it better for our kids, to make our students to experience on the daily bases better, but we [teachers] weren’t” (N/11/18/05 P.1). Afterwards, he realized that the purpose of the faculty meeting was not to solicit teachers’ view, but to allow the school administration to “pretend” to invite teacher input.

In Nathan’s view, there was no input from the teachers and manifestly it was not allowed, unless for a group of teachers who were in the special group and he noted “if you’re in the selected group of teachers whose opinions matters” (N/11/18/05 P.1). In support of this perception, Nathan saw that during one faculty meeting another teacher expressed the exact same ideas that Nathan had said previously. Unlike the disregard that he received for his opinions, Nathan observed that “not only she was not in trouble; she was applauded for her depth and insight. And I am sitting here and I’m like ‘didn’t I say the same thing three weeks ago and I almost lost my job?’” (N/11/18/05 P.2).

Suddenly his great enthusiasm to contribute Kent High School was transformed into personal survival concerns. From that meeting to the end of the first semester, Nathan experienced a great deal of stress about the prospect of losing his first teaching job. He explained “[the school administration] wanted to fire me for the entire month of September. And coming to work everyday was miserable because I walked on egg shells for a month, a month and a half” (N/06/09/06 P.2). Thus, rather than being perceived a competent member of Kent High School, the object of Nathan’s activity system narrowed

and formed a new object that emphasized his survival during his first year. He explained this change as following,

I'll never be the teacher that I was. I'll never view it the way I did it a year ago. It was exciting you know. I love reading my teaching philosophy. And I would never make any changes to that but I don't think that I can write that anymore with the realities of what I've received this year. And that's sad. And it's taking me a long time to get as close as I am to that. I don't wanna write another one [teaching philosophy] because what I wrote was wonderful, was great. But I know that if I had to write one now, I could not reproduce that. (N/06/09/06 P.2)

Clearly, his survival concerns played a significant role in shaping his emotional state. In turn, his emotional states influenced his teaching practices in various different levels, from his socialization with community members to his classroom practices.

The role of negative emotions in shaping practice was most easily seen during Nathan's efforts in his "4th block" class. What began as a difficult class to manage became a class that Nathan lost interest in and lowered expectations for: "Well, the 4th block is still off the wall. I don't enjoy that class. I don't. I don't enjoy teaching them...I don't perceive the majority of my students are having an interest in school" (N/02/03/06 P.6). Nathan assumed it might be the scheduling problems since the class was in fourth block and he indicated:

I am just tired of that class. I want it to be over. You know the first, from 7:25 to 12:30, first five hours of school goes like [snapping his fingers] that. And then the last hour takes forever. It is unfortunate but it just drags everyday. (N/02/03/06 P.7)

"I don't care. I really don't. That is their decision." (N/02/03/06 P.7) Nathan explained "that is a class that goes all alone. I have no control over them at all. And I very much dislike this class. And I approach it very differently" (N/01/13/06 P.2). "I don't care. I really don't. That is their decision." (N/02/03/06 P.7)

During his early days in his first year, Nathan occasionally tried to facilitate labs with his students in the 4th block. Nathan explained that his students broke equipment, they tend to harm each other, and it was very difficult for him to manage them during the activities. After couple of tries, Nathan decided to not to "put myself in a situation where

I may lose” (N/02/03/06 P.13). Since he did not trust his students to do labs, Nathan explained “I am not going to take risk on my career because one of them gets a burned face or glass in the arm.” (N/01/13/06 P.5)

Because of this, Nathan explained that his fourth period students “deserved” only a “college style course” where he lectured for 25 minutes and “they come in, they do book work or they take notes. That is what they do. They do a work sheet then we take a test. That is all.” (N/01/13/06 P.5)

Nathan’s emotions about his students were clearly reflected in his teaching practices. However, he argued that his decision was a result of his students’ careless attitudes and their persistent misbehaviors. For Nathan, since the students did not care and try to learn Earth Science, he stopped trying to “reach them” and he “let them fail”. ” I don’t care about that class anymore, and I know you’re not supposed to say it... to ever not care about a class but I don’t. (N/02/03/06 P.13)

It is interesting to note that Nathan’s negative emotions surrounding this class were in part in response to their failure to accept his identity as “student-centered” friend of the student. Because they failed to accept and respond to this identity in the expected manner and cause substantial management concerns, Nathan “cut them off”, he lowered his expectations of them and acted on these low expectations. This began a negative spiral, as his negative perceptions and low expectations were evident in this classroom, causing an increase of management problems on the part of the students.

Nathan’s negative emotions surrounding school administration and other teachers also caused him to be even less receptive to offers of support. It is important to note that teachers in the science department attempted to help Nathan with designing lesson plans and activities for his Earth Science teaching, offering support to the novice on their team. However, Nathan was reluctant to accept their assistance, and he continued to perform a self-sufficient teacher identity with this group. The community was offering support, while Nathan craved recognition of his efforts. Therefore, when Nathan recognized that his community failed to recognize him as a competent effective member of their community and instead viewed him as a novice, he reacted in negative terms. He was incapable of performing his preferred identity and so responding negatively, he actively sought places in which his identity could be recognized and valued by his students. And

because of lack of positive recognition from the other teachers and especially the school administration, Nathan indicated “I don’t do anything because I don’t care. I don’t feel responsible for this school anymore.” (N/01/13/06 P.4)

However, by the end of the first semester even Nathan found himself questioning his own identity as a champion of students, as he examined his teaching practice with his 4th block. Nathan found himself “becoming vindictive with the grading” because of his negative feelings about a particular student (N/01/13/06 P.4) who complained to the school administration, suggesting that Nathan had sexually harassed her. He explained:

...she was saying I am sexually harassing the class... but it wasn’t me sexually harassing the class. It was me not taking a strong enough stands against sexual comments directed at me... (N/01/13/06 P.4)

Nathan realized his failure to facilitate appropriate classroom management resulted in this situation. However, this event was not enough to cause him to search for remedies and alternative approaches to avoid such problems. Instead, he emotionally withdrew even further from this class of students.

Given Nathan’s need to be perceived as an excellent and extraordinary science teacher, the contradictions that he experienced often invoked strong emotional responses, which greatly impacted his belief system, practices and future career decisions. Indeed, his first-year teaching included a significant amount of change, alteration and ultimately object formation.

Based on his first semester experiences, Nathan realized that it takes many things to be a good science teacher. Nathan indicated that his preservice education provided him with proficient amount of preparation to teach science. However the quality preparation that he received, Nathan explained that in order to practice what he knows, teaching context was very crucial. And he noted “You can know can know how to be a great science teacher but you also need to be in the right situation.” (N/12/26/05 PP. 1-2)

Evidently, Kent High School was not the right context for him to practice his teaching goals, and he explained:

I know how to be a good science teacher...but I am not in the situation that allows my abilities, my natural abilities to come into play...I am better with higher level kids. Things I wanna do, I can not do with these kids. I enjoy reading and asking

them some of these more esoteric questions. How does this impact our lives? Who does this metaphor when we read like an article? And they're not able to make those deeper connections... (N/12/26/05 P. 2)

As far as his future career in teaching, Nathan did not want to teach at Kent High School for the following school year; thus in the second semester, he began searching for other teaching positions for his second year in teaching. Although, Kent High School administration offered to reappoint Nathan to his position for the following year, he preferred to become a *mover* (Smith & Ingersoll, 2004) since he believed that the Kent High School community would never recognize him as an excellent science teacher. The prospect of his students' scores on the upcoming standardized assessment magnified this fear, as he was sure that his students would not perform adequately.

I argue that his first-year emotional states also played significant role in molding his future career choices. Through the lens of his emotional needs, Nathan preferred to devote a vast amount of his time into his Masters' studies rather than his teaching practices during his first year in teaching. The university provided Nathan with the validation he needed, while the school failed to. This made his decision to eventually leave the classroom to pursue a further degree seem clear-cut.

Object

For Leont'ev (1978) the center motivation of every individual's activity is toward a particular object. Similarly, Engestrom (1999) points that as an ultimate motivating force the role of the object is to shape and direct the activity; thus, an appropriate understanding of an activity depends upon a well-defined grasp of its object. CHAT describes that in an activity system, there are both individual and institutional objects leading the activity system of a work environment (Davydov, 1999; Engestrom, 1999; Sounders, 2006). The interaction of these two objects is essential to the development of novices as they become a competent part of the existing activity system. In these terms, the patterns in a novice's object formation helps explain why the novice works to hone skills needed to function effectively in a work environment. In object formation, the novice's primary object moves from an initial state of unreflected, situationally given format, to a collectively meaningful object, eventually changing into a shared or jointly

constructed object. The construction of any object entails a dialogical interaction between aspects of the subject's personal experience and his/her relationship to members of the wider community pursued (Engestrom, 2001).

Identifying an object and the process of its formation has an essential importance in the CHAT framework. Many activity theorists work to understand how a collectively constructed object and individual's goals interact with each other and how this interaction may further influence the object formation process during the course of an activity (Davydov, 1999; Foot, 2001). In Nathan's activity system, the object of this research was Nathan's transformation in becoming a recognized professional of Kent High School's activity system, as well as the transformation of his teaching practices mindful of science education reform.

Given that Nathan had his specific teaching goals and set of teaching philosophy to practice, it was crucial to observe Nathan's object formation and transformation of his other personal goals. It was also essential to keep in mind that the collective activity system of Kent High School also had its own goals, which historically and culturally evolved during Nathan's first year. Special emphasis is also necessary to understand how the interaction of personal and collective goals embedded in Nathan's first-year activity system influenced Nathan's object formation during his first year at Kent High School.

The identification of object required a complex process of analysis over time, since the contradictions between collective and personal goals impacted on much of Nathan's object formation during his first year. As, Engeström and Escalante (1996) point:

The object should not be confused with a conscious goal or aim. In activity theory, conscious goals are related to discrete, finite, and individual actions; objects are related to continuous, collective activity systems and their motives...

The slippery and transitional nature of objects sometimes evokes a denial of their very existence. (p. 360)

Given this interrelated nature of object formation in an activity system, I explore how Nathan's object transformed into survival concerns because of the contradictions among Nathan's personal goals and Kent High School's collective goals as well as the County's goals during his first year.

During his short experience in teaching, Nathan acknowledged that there was a conflict between what teachers and policy makers expected from education. According to Nathan, the teachers' main concern was to seek to provide "every single one of our kids, our children" with the best education, whereas the policy makers' goal was to deliver "enough, efficient education to meet the minimum standards" (N/12/26/05 P.3). Because of the friction prompted by the system of accountability, schools like Kent High School appeared to be unfriendly places for first-year teachers. With Nathan's need to be perceived as able and capable, as he internalized the existing system of accountability, a dramatic change occurred in his future plans. Indeed, the change started with questioning about his position in the existing educational system. Nathan questioned what his role in education was and then he understood that it was impossible to bring a systemic change with "small battles" by teaching science in a high school. Thus he noted:

I am asking myself is it better to fight the smaller battles and win or bigger battles and probably lose. I can get my PhD by the time I am thirty two and write four articles a year after next three years and publish a book every three years so I would have hundred and something articles and twenty books. And how much change does that bring about? Out of this I am just kinda [trying to] find my place where I fit...I am still debating. Maybe there is a role I can, maybe being a professor, a role I can take and bringing about these changes that I like. Maybe I can become a lobbyist something like that. (N/12/26/05 P.3)

In terms of his long-term career choices, a combination of his naïve preservice perception and his ineffective first-year experiences influenced his beliefs about the broader system of education. Nathan explained that his negative experiences helped him to realize "the big picture." At the beginning of his teaching career, Nathan was "very idealistic" in order to make a change "You wanna have idealism and you wanna be saving the world" (N/12/26/05 P.2). After his first year of teaching at Kent High School, Nathan understood "Education [the system] is bigger than just educating our kids." (N/12/26/05 P.2)

By the end of his first semester, Nathan decided to pursue his PhD degree in education. He believed that a Ph.D. degree in Educational Policy would help him to achieve his goals--that of transforming the system to better meet students' needs. This

transformation required that he no longer be in the classroom, but instead, work as a professor or a lobbyist to effect change. Notice this choice allowed him to maintain his strong, student-centered, champion identity, and without the contradictions in the classroom, allowing him to maintain his identity as a competent teacher as well.

Additionally, dramatic changes were also obvious in Nathan's personal goals. As far as changes in his teaching philosophy, Nathan came to an understanding that not all of his students were able to learn science because he came to think that some of his students did not have an essential "natural talent" and motivation to learn science. Additionally, Nathan left his first-year teaching with a perception that enactment of science education reform especially teaching science through inquiry was a disservice to his students.

As far as Nathan's externalization of these contradictions, his first-year activity system illustrated no specific externalization that Nathan attempted to resolve these contradictions. His immediate reactions to these contradictions were limited to his adoption of teacher-centered teaching practices and his plans to change schools for his second year. His long term reaction to the contradiction was his decision to pursue a PhD degree in education as his future career path.

Community

Lemke (2002) describes that as individuals participate in community life, they become like other people as they realize the diversity of views through social interactions with others. Within the framework of CHAT, communities and their members are constitutive and as they function and interact, they develop a set of cultural values and beliefs. It is through participating in such joint interaction that individual members of a community learn certain values and beliefs of that society. At the same time, because of the possible contradictions that arise within a particular community, through the participants' collaborative work to find creative solutions the community may use to transform. This transformation can occur through the development of new abilities and skills to lessen the contradictions for future generations of the community. On the other hand, in some cases, if the community fails to address and eliminate these contradictions, the contradictions remain as sources of perpetuating struggles for the newcomers, thus the unsolved contradictions may exist to be potential emotional disputes for novices in

that community. The following are the significant community members in the activity system of Nathan at Kent High School.

School Administration

The persistent underachievement of the school played a significant role in shaping the school administration's perception about teaching and learning. Improving the scores on state wide standardized achievement tests and fulfilling the requirements for satisfactory yearly progress seemed to be the main priorities of Kent High School administration. Because of the overwhelming nature of these demands, the school administration placed relatively no significant emphasis on other issues within the school.

Given Nathan's early introduction to the school administration during his internship experience, at the outset of the year, he thought that the school administration devoted all of their efforts to improving students' achievement. In choosing to become a part of this school as a science teacher, he aimed to "fight their fights" and help them achieve their goals. In contrast, he did not hold the science department in the same high esteem. He noted "I thought my administration was great and my department was crappy when I started based on my experiences with student teaching. I thought my department was always making trouble and being antagonistic." (N/11/18/05 P.1)

After his first weeks as a teacher, Nathan realized "the bigger picture" and he perceived that his department was "great because they just want what is best, what makes sense, how we're gonna make Kent and the students better" (N/11/18/05 P.1). On the other hand, "...then the flip side, my administration is terrible," and he saw them as very unsupportive of teachers.

There is this [attitude by the administrators] if you're not with me you're against me. If you disagree with them what an administrator does, you cannot ask a question, you can't say 'why are we doing that?', '[can you] justify it?' You can't. There is no justification. (N/11/18/05 P.1)

Nathan described his principal as "non-participatory", "non-existing, doesn't do anything." Likewise, except for the vice-principal responsible for attendance, Nathan's perceptions about other administrative staff at Kent High School were also negative. He specifically noted that vice-principal for curriculum was a former elementary teacher who

lacked high school experience. Nathan understood her to be overwhelmed and hesitant to listen to teachers' ideas. Nathan explained that this vice-principal viewed suggestions as personal threats rather than valuing others ideas as opportunities to improve the school. These views of administration were shared by other members in the science department. Mr. Clair, head of science department, explained that the Kent High School administrators "don't trust the good teachers and experienced teachers to do their job." He specified that the school administration solely wanted to impose things upon teachers through assigning them additional tasks. (M/05/02/06 P.4)

Obviously, the historical pressure was originated by the long-term failure of the school's students on state standardized assessment. This resulted in the administration taking a "top down" approach to improve test scores, in which the administration ignored other community members (experienced and novice teachers). For Mr. Clair it required a lot of dedication for principals to improve student achievement. However, he believed that a successful principal should be "out working with the teachers, working with the students" (M/05/02/06 P.5) and this was not the case of Kent's administration. My attempts as a researcher to interact with the school administration supported the pattern described by Mr. Clair and Nathan. Throughout the year of my study, despite repeated attempts, I was unable to schedule an interview for this research.

As mentioned earlier, Nathan's relatively early conflicts with the school administration resulted in a very dramatic change in Nathan's first-year expectations. Rather than seeking to become a change agent as an excellent science teacher of Kent High School, working to enhance students' achievement and teaching science through student centered practices mindful of science education reform, Nathan's object of first year became a real concern of his professional survival at Kent High School. Rather than seeking to become a member of a wide professional community, he maintained an insularity that worked to prevent professional development. At that meeting, he noted "[the school administration] ripped part of me out and until it is sort of healed, the wound was healed I couldn't move. And so, my motivation wasn't as high as I would have liked" (N/06/09/06 PP. 3-4). He indicated that all of his teaching goals were affected by the school administration's attitude toward him. Therefore Nathan noted:

I couldn't you know push envelop with teaching practices why? Because I was afraid they'd say "Oh not only as he hardhead but he is not doing any good job," and fire me. You know so, I felt back on a lot of didactic methods because I was afraid that they might walk in. (N/06/09/06 P.4)

Evidently, Nathan's survival concerns appeared to be a prominent reason for Nathan to teach science through the traditional, teacher-centered way. According to his perception, teacher-centered way of teaching was an acceptable to his school administrators.

Teachers and Sense of Collaboration

According to Nathan, teaching and learning were strongly interconnected, so in order for to provide effective learning experiences for unmotivated students, collaborative work was crucial. However, Nathan pointed out that it seemed relatively impossible to set up a collaborative work environment at Kent High School because the administrative pressure within the school caused each individual teacher a concern to "get through it" (N/02/17/06 P.1). Nathan specified,

I can't fault them [the teachers]. That's how they get through the day. And some days that is all I wanna do, get through the day, [and] get through the week. This week I'm glad I got through this week without killing anybody. (N/02/17/06 P.2)

Nathan noted that because of the school culture and student population at Kent High School, it was common that teachers solely "fight their own battle" to survive the day, week, or the entire school year. (N/02/17/06 P.1)

As far as Nathan's perception about sense of collaboration among the departments, it became apparent that the science department had little to no collaboration with other departments other than mathematics. Unfortunately, the science department's attempt to cooperate with the math department to enhance the effectiveness of daily math 'warm ups' was not successful.

In terms of his communication with other community members at Kent High School, when he first started his teaching at Kent High School, Nathan was welcomed by some teachers. Nathan's convivial personal characteristics helped him to build up strong communication with some of the teachers who were from other departments. Despite these good relationships, Nathan perceived that there were "a lot of teachers that dislike

me” because of his outspoken personality. According to Nathan, this dislike was because that he “spoke out loud” and some of the teachers at Kent High School did not feel that he “has the expertise as a teacher to have an opinion.” (N/11/18/05 P.8)

Clearly, Nathan’s relationship with other teachers was complex. For instance, one teacher from another department asked Nathan for help with a student’ with anger management since the teacher believed that Nathan he had a good relationship with that student. The teacher asked Nathan to talk to the student about the problem. Afterwards, Nathan tried to talk to the student. However, the student rejected his attempts, and ran away from Nathan. Nathan walked behind him and said “We’re not done yet, you don’t need to deal with this now, but I wanna help you.” Afterwards the student was very angry, and he went into a classroom and Nathan followed after him. Nathan told the student, “Please come out here we’re not done.” And a teacher in the classroom slammed the door on his face. Nathan felt that that teacher did not give him the benefit of doubt nor she did allow him to explain. Nathan noted that the teacher felt it was “more important” for that student to learn “ $3+3=6$ than to talk about a behavioral issue.” (N/11/18/05 P.8, 9).

Within the context of Kent High School and given the disadvantaged home life of the students (from Nathan’s perspective), Nathan believed that behavioral issues were more important than teaching and learning, arguing that there should be a strong collaboration among teachers to address students’ behavioral issues within the entire school. However, evidently Nathan did not get the sense of strong communication and collaboration among the teachers of Kent High School in terms of students’ behaviors. Thus, this lack of collaboration at Kent High School led Nathan to accept the status quo from his students, and to spend most of his time socializing with “my students and their friends” at Kent High School.

As opposed to his relationships with the school administration and other teachers Nathan was not displeased with his relationships with the teachers in his department. There were eight science teachers, and six of them were teaching an extended day, having lunch duties and after school responsibilities. In Nathan’s view, most of the science teachers were very successful veteran teachers and the decisions they made mainly for “the best interest of students” (N/11/18/05 P.3). For example, in Nathan’s view, his

department head had one of the best AP Biology classes in the entire city because “he gives [students] lab experiences. [Whereas] most of the other AP Biology teachers, it is just lecture, and homework.” In terms of Mr. Clair’s AP Biology class, Nathan expressed students’ learning as “When they’re asked to use the micro pipe they know not only how to use it but what a micro pipe is” (N/11/18/05 P.3). Earlier, I described that Nathan was not “displeased” with the science teaching community, as he acknowledged their expertise--but he did not often look to them for support or aid in his own development as a teacher.

Although the official first-year teacher mentor of Kent High School was a science teacher and Nathan’s former cooperating teacher, Nathan’s communication with his official mentor teacher was limited. Rather, he perceived Mr. Clair as his unofficial mentor during his first year at Kent High School. Evidently, Mr. Clair played a significant role in helping Nathan to continue working at Kent High School during the times of crises. Although his department head had a very busy schedule, Nathan was able to talk things over with him whenever he needed help. For Nathan, it was because of Mr. Clair’s positive encouragement and support that Nathan was able to complete his first year at Kent.

Thus, because of the sense support and instructional dedication that Nathan observed in his department, Nathan noted “being a part of his department feels very good.” (N/12/02/05 P.5). In spite of his overall contentment with the other science teachers, during the course of his first year, Nathan did not participate in any curricular and extracurricular communities of the practice within the science department. Perhaps because of his lack of involvement in community of practice, Nathan did not feel that he contributed to the activity system of Kent High School. As discussed earlier, through participation of community of practice a sense of contribution to an activity system enhances novices’ positive emotional energy and sense of membership to a community (Collins, 2004; Olitsky, 2006). But this strong sense of community did not exist for Nathan at Kent High--within or outside his department.

Students

Kent High School students were also another essential part of Nathan's first-year activity system. To gain a better understanding of the student population of the Kent High School, Mr. Clair provided a profound account for the general characteristics of their student population drawing upon his 10 years of experience. For Mr. Clair, students at Kent High School commonly had limited prior experiences related to schooling or academics, making teaching difficult. Although I explored this deficit mentality (Haberman, 1991) in detail in the section on the norm and expectation of Kent High School, it is important to note that the Kent High School community's overall perception about the student body largely consisted of teachers' low expectations from students. Issues such as poverty were clearly embedded in home lives of many of the students influencing their academic performance, and that was clear to all that worked at Kent High. According to Mr. Clair, approximately 75 percent of the student population experienced these disadvantages and many of his students were from families that failed to provide academic support for their children (i.e., making sure that homework was completed, staying in contact with the teachers, high grade expectations). On the other hand, Mr. Clair pointed out that their high achieving students, the upper 25 percent of the student population, typically had very supportive families. So while Mr. Clair could see both the challenges and possibilities represented by his students, for Nathan the challenges seemed overwhelming.

Nathan saw this all as a negative spiral. Because of their consistent poor performance in school, many of the students were "constantly confronted with not being good and they believe it" (N/11/18/05 P.2). Because of these low expectations, students, in turn, generally "don't care" about school, losing motivation to exert themselves, to really attempt to be successful. (N/11/18/05 P.2) For Nathan, as a result of the constant low expectations culture perpetuated within the entire school system, students came to believe that they could never meet high expectations at Kent (and for Nathan it seemed that this was true for almost all the students, as he could not distinguish between high and low achievers). Early on, Nathan tried to send his students a message that "they can do it if they want" (N/11/18/05 P.2). In this, Nathan considered himself to be an outlier, the only teacher who persistently delivered an alternative positive message to students that

they could be successful. For Nathan, it was relatively critical for the entire school community to emphasize the same high expectations in order to empower students to believe in themselves and become successful students.

As the year progressed, Nathan's attempts to project a sense of high expectation were contradicted by students' behaviors in his classroom. Given his lackadaisical classroom management and lack of planning, students quickly became accustomed to "pushing the envelope" in his classroom, behaving in ways that made teaching very difficult (taking cell phone calls, speaking out, throwing papers, refusing to comply with requests).

I'm not saying that I was an angel when I was in high school. But I don't know of behaviorally I was misbehaved as they are. I don't think that I, I didn't curse at my teachers not and not at me. But I've never cursed in front of them, I've never disrespected them. I mean there were some I did but they wanted it, but I never, teachers that I like I never disrespected if a teacher told me to stop talking when I was talking. I didn't take that as a front to me because I really was doing what I wasn't doing. (N/11/18/05 P.5)

For Nathan what he did was not teaching most of the time, he explained "I feel like I am a baby sitter half the time. (N/11/18/05 P.5). Students' behaviors, combined with his approach to classroom management and lesson planning, made student centered instruction a thing of the past by mid-year.

Nathan also justified his abandonment of his high expectations based on student preparation for his class. Nathan quickly pointed out the inadequacy of his students' science preparation and he gave voice to "a great deal of contempt" for their elementary and middle school teachers (N/02/17/06 P.3) "It is disgusting that you can be a 9th grader and not know where the seven continents are." Nathan attributed much of his students' limited science prior knowledge to their lack of rigorous preparation. For Nathan the students were working from a deficit, but not just in terms of family support, but also in terms of academic preparation. The mismatch between Nathan's preservice expectations and his students' low level remained another crucial contradiction in Nathan's activity system, one he understood in contextual terms, and one that he felt powerless to address.

University Professors

A particularly salient aspect of Nathan's first-year activity system was his university professors and his continued communication with them. Since he was a continuing master's student at science education program, Nathan spent considerable amount of his time at the university and he often communicated with his major professor in science education to talk about his first-year experiences as well as his master's thesis. After his disappointment early in his first semester of teaching, Nathan came to think of his graduate studies as far more important than his teaching Earth Science at Kent High School. Because of his personal identity, it was very critical for Nathan to be recognized as competent individual in a community where he participated and contributed. Given Nathan's need to be perceived as competent, student-centered, and a champion, he gravitated toward membership in a community that allowed him to perform this identity, gravitating toward and coming to value his time at the university. Most of his conversations with his major professors and his friends were about the lack of support that the school administration provided Nathan and the difficulty of implementing his best, reform-based ideas within unsupportive Kent High School environment. He didn't use these opportunities to search for alternatives or to share his disappointment, but rather focused his conversations on an examination of the broader issues of schooling as evidenced at Kent. In these interactions, he once again focused on the context, but not his actions within this context.

Division of Labor

Originated from Marx (1976), division of labor refers to the distribution of tasks authority and benefits among all the participants of an activity system, who share the same object. Donato (2004) signifies that the division of labor in collaboration typically leads to learning outcomes and forms of societal activity through mediating learning, but this is was not seen in Nathan's case. Nathan's active participation in the broader activity system of Kent High School was limited to his regular teaching responsibilities. It is also important to note that much of the school administration and teachers perceived beginning teachers through the lens of traditional apprenticeship perspective, in which novice teachers' participation to curricular and extracurricular activities was not

necessary. Thus, through a close look at Nathan's first-year activity system, this study illustrated that Nathan did not play an active role in the school's larger division of labor because of his self-sufficient identity and overall perception about the school community. The purpose of this section is to explore the role of the division of labor played in shaping Nathan's activity system. Specifically, the section focuses on Nathan's responsibilities and his professional development activities (including support programs and mentoring).

Nathan's First-year Responsibilities

Nathan was responsible for teaching three 9th grade Earth Science classes offered on a block schedule in his first semester. One of his Earth Science classes was a year long and the rest of his classes were semester long classes. In his second semester, including his a year long Earth Science class, Nathan was responsible for teaching two Earth Science classes (one continued from the previous semester) and one elective Astronomy class (including students from a mixture of grade levels).

Kent High School used a block schedule, so that there were two discrete semesters during a school year. Such scheduling required teachers to teach four, 90-minute length lessons in a regular day. Nathan had two separate sets of teaching responsibilities for each semester during the school year. Most of the time, Nathan had difficulty using the classroom time effectively as he mainly used lecture-based instructional approach where it was difficult for Nathan to facilitate 90-minute lessons. His lack of content knowledge and lack of effort to remedy his teaching restricted his use of teaching time. In order to engage his students, he often preferred to talk about daily life issues and sometimes social and political issues in his class. Thus, Nathan considered block schedule as one of the external aspects of his context that prevented him achieving his teaching goals and even though he recognized this difficulty at the outset of the school year, he saw no alterations as possible--and he had to simply continue on as he had been practicing.

In Earth Science, Nathan was required to teach the State Standards, and his success was to be measured by students' achievement on the state-wide achievement test. The district curriculum guides and the state standards explicitly outlined the required

content for this course. However, Nathan did not illustrate a full grasp of the requirements. He noted “I’m not sure what is required of me right now. I know what I wanna do but I don’t know what is required of me” (N/03/01/06 P.12). He also assumed that he would be able to know the requirements by the end of the school year. However, as the year progressed, Nathan came to recognize that teaching standards were important and “they can be compatible with the accountability” (N/03/01/06 PP.12-13). This realization is interesting in that throughout the methods courses, Nathan was responsible for using the standards in each of the lessons and units he designed. But his responsibility to teach these standards did not seem “real” to him until his first-year teaching.

Nathan explained that teaching mindful of science education reform was essential in an era of accountability in that such teaching practices better ensure students’ effective learning experiences. But this assertion was not evident in his practice, or in his thinking about his own practice. When discussing his teaching in earth science, Nathan explained that his teaching science through reform was unrealized because of the contextual constraints he was operating within. This explanation, though compelling, loses a bit of his explanatory power when one reviews the manner in which he taught Astronomy, a course not addressed in the state achievement test and a course with much older and better behaved students. The teaching in this course also failed to reflect his reform rhetoric.

As far as Nathan’s responsibilities other than teaching, during his second semester, the school administration assigned Nathan a lunch duty. For this, Nathan had to be present at the student cafeteria during students’ lunch break. It was quite evident that Nathan did not feel overwhelmed about his lunch duty; rather it seemed that the time that he spent during that duty was an opportunity for Nathan to communicate with the students. During the lunch break, he liked to talk with students and make jokes with them. It was also evident many of his students enjoyed his company during this time.

Except for teaching and lunch duty, Nathan did not have any other responsibilities during his first year at Kent High School. As a part of the District’s requirement for first-year teachers, Nathan participated in the first-year teachers program as well as associated paper work also required for first-year teachers. The paperwork requirements included his

first-year teaching portfolio as well as observation requirements fulfilled by the school administration and mentor teacher. In Nathan's view, the District's requirements were solely formalities, requirements that drained away valuable time but failed to serve as a source support or guidance.

Although his responsibilities were no more than any other first-year teachers, time constraints seemed almost an overwhelming challenge for Nathan. Paradoxically, his graduate studies became even more important for Nathan as he failed to experience an effective first-year teaching at Kent High School. Nathan noted that "I've got so much on my plate and I don't really think about my teaching" (N/02/13/06 P.6). Evidently, his graduate school responsibilities dominated much of his time during his first year. As a first-year teacher, he said "Little did I know how difficult that is" to be an effective science teacher and a successful graduate student at the same time. (N/11/11/05 P.4) Thus, he noted,

I don't wanna fail my [graduate] class, OK! But it is hard finding the time for both too. And come home after the school, most days I am at the school till at least 4 even though we're supposed after school, to leave at 2:30. I am at school from 7 till 4 most days. And there are days I am there till 7 or 8 o'clock, because I gotta get stuff done. But what happens is that I get home I feel so tired and I am like, you know "forget it!" (N/11/11/05 P.4)

Nathan noted "I did it to myself" but he said "I am not saying that it is not getting done, it's hard" (N/11/11/05 P.4).

As an outcome of his decision to invest his relatively limited time into his teaching, Nathan was not able to prepare effective activities and lessons or look for alternative ways to facilitate his students' learning. Thus, after a brief interlude of activity based nature of science activities, Nathan's predominate teaching approach for both Earth Science and Astronomy was lecture. He was aware that lecture-based science teaching was in stark contrast to his personal teaching philosophy. Nathan noted "There are days, I question whether I'm teaching for their [students] needs." (N/01/13/06 P.2)

His devotion to his graduate work (as well as his preparations to leave Kent High) left scant time to invest in his teaching, negatively impacting teaching practice. It was evidence that Nathan often taught with almost no formal or informal planning and

preparation. Thus, lecturing and triadic dialogues, augmented by book work became staples of Nathan's teaching. While his master's program enriched his understanding of the reforms, Nathan did not attempt to enact these understandings in his own classroom--largely because he understood the contradictions in his situation as overwhelming.

Support for Professional Development

There were several mandatory first-year professional development activities required of Nathan during this first year. As far as the official professional development activities, the District required each first-year teacher to attend a first-year teacher support program developed and facilitated by the District itself. Besides that, the District also required each school to assign an official first-year teacher mentor for the beginning teachers as well as observations by administrations to ensure that the beginning teacher developed the necessary skills for predetermined teaching competencies. At the end of the school year, the District assessed each teacher's progress to certify them as a competent teacher through reviewing their participation to the first-year support program and their first-year teaching portfolios, as well as the report forms filled by the mentor teacher and the school administration.

In terms of the unofficial professional development activities, the other students in Nathan's graduate courses and Mr. Clair seemed to be the most important avenues of support.

First-year Teacher Program

All beginning teachers in the district were required to attend the district-wide "First-year Teacher Support Program," a program designed to meet what were considered to be immediate professional development needs; classroom management, ethics, abuse, reading across the content areas, and technology. The program was scheduled for the second semester of the school year.

For Nathan the District's first-year teacher support program was "horrible" and he declared that the program helped him to be "less effective teacher" through "wasting his time" and "frowning" on him about pursuing his master's study. Nathan specified that the program and individuals who were part of the program "didn't know anything about education." (N/06/09/06 P.5)

He indicated that his preservice education dealt with many of the issues that the support program addressed. Nathan noted “I got to sit there and watch Harry Wong for the third time. I know Harry Wong, I met him, and I shook his hand. So, why I got to sit there and waste my afternoons for three hours” (N/06/09/06 P.5). Nathan perceived the program as redundant to his preservice education--redundant and ill-conceived. According to Nathan, the District’s ineffective policies and regulations were consequences of the weakness of the state toward education in general.

Additionally, Nathan also criticized that the timing of the program was another contradiction for many teachers. Rather than requiring beginning teachers to attend this program during the school year, he thought that the program would be more effective if it were offered at the beginning of the year. He specified that the current organization of the program did not provide practical help for some teachers, especially those who did not have a preservice background. According to Nathan, it would take time for these new teachers to practice what they learned in the program as they had to teach at the same time. Thus, Nathan thought that the District should provide this support program at the beginning of the school year so that it would be more effective and supportive for beginning teachers.

As far as the instructors of the program, Nathan had relatively negative perceptions about how they approached beginning teachers’ professional development. He thought that rather than getting the support that he needed, the support program discouraged him to pursue his master’s study, which he perceived as one of his professional development activities. One of the instructors at the program realized that Nathan was pursuing his master’s degree along with his first year in teaching, and the instructor openly indicated that it was not a good idea to pursue another degree for beginning teachers during their first year in teaching because of the challenges embedded in the transition process of beginning teachers. However, Nathan perceived the instructor as very close minded to understanding the values and support that he had been receiving from his graduate course. Nathan stated:

My Master’s degree makes me a better teacher because it’ll make me, if I didn’t have, haven’t pursued my master’s degree, one, I would not be nearly as aware or in supportive of the reform movements as I am. Two, that whole God and science

thing ... there is no way I would have been able to answer that as effectively and satisfying for not only me but for my students. For some of my students that's a real issue. (N/06/09/06 P.5)

One of his master classes that Nathan took was the History of Science and Religion. He believed that because of this class he grasped a better understanding of a central contradiction that arose in his teaching at Kent High School. The impact of these classes on his beliefs about nature of science was quite evident. As will be discussed in chapter 4, by the midterm of his teaching, Nathan perceived that it was a science teachers' role to provide a mid-way view between religious and scientific views for his students, allowing students to see the relevance of both ways of knowing.

Although Nathan perceived the first-year teacher program as a waste of time, ineffective, and providing no theoretical and practical help for him to improve his first year in teaching, the only aspect of the official program that Nathan found helpful was the focus groups. In these groups, all the beginning science teachers in the district came together to share their classroom experiences and others were able to learn and reflect on these particular experiences under the guidance of an experienced science teacher. One of the experienced teachers that lead the focus group discussions was Mr. Clair, Nathan's department head. Nathan found him very helpful because he held an expertise about the problems and issues which were "unique to science education." (N/06/23/06 P.13)

Mentoring

In addition to the first-year teacher program, the mentor teacher was another official support for beginning teachers. The mentor teacher was required to do observations and give feedback to the novices using the Clinical Supervision Model outlined by the District. The school administration appointed Mrs. Moore as the official mentor teacher who was responsible for mentoring eight beginning teachers including Nathan during 2005-2006 school year at Kent High School. Mrs. Moore was an experienced Chemistry teacher in the science department. She was also Nathan's cooperating teacher during his student teaching period.

Given that she was previously his cooperating teacher and also mentor teacher, Nathan realized that the role of a mentor teacher was very different than the role of a

cooperating teacher. Nathan described that during his student teaching, Mrs. Moore's primary focus was to ensure Nathan's effective student teaching experiences in her class. In contrast, because of her own responsibilities at Kent High School, she was not able to utterly focus on Nathan and his development during his first year. Nathan asserted that it was because of her overwhelming teaching role and extracurricular responsibilities that she did not have enough time to support Nathan sufficiently. Indeed, her schedule did not allow her time to speak with me about Nathan's first experiences. After my persistent communication inquiry, she emailed me that in addition to her responsibilities at Kent High School, she had two other jobs so that she was not able to talk or even respond to my questions in writing because of time constraints. Thus, it seems that part of Nathan's perceptions were correct: Ms. Moore was so burdened that focused attention on Nathan and his development was limited.

In terms of Mrs. Moore's mentoring service for Nathan, Nathan perceived that she was "always willing to help out" and was "watching out for [Nathan] and offering any help she could" (NM 06/09/06 P.2). Despite the fact that she cared about Nathan, Nathan sometimes perceived her approaches to him as "annoying." Early in his first year, Nathan realized that Mrs. Moore was very interested in his teaching. For Nathan, his mentor teacher liked to "control" (N/02/03/06 P.3). In addition to that, Nathan also realized that she criticized Nathan about his inefficient preparation of his students for the state achievement test. Nathan perceived that her critiques were unfair and her approach was not being empathic to Nathan's particular circumstances. For Nathan, Mrs. Moore was teaching upper level students who mainly held a great promise to pass the test even without a teacher's involvement, whereas Nathan had to teach "low level", "disadvantage students." In addition to his student population, teaching Earth Science was quite challenging for him. He believed that if he had the content knowledge required and the students that his mentor teacher was teaching, he would be very successful.

Thus, because of his competent and self-sufficient identity, Nathan did not necessarily solicit any instructional help and suggestions from his mentor teacher. The only help that he asked for was about "technicalities of school," such as reporting grades, filling out required first-year teacher reports and such during his first year at Kent High

School. (NM 06/09/06 P.3) Nathan indicated “that’s not something that you’re prepared for” during the preservice education.

Other Official Support Programs for Nathan

There were also several responsibilities that the school administration was required to fulfill. Technically, this responsibility was addressed via an observation of Nathan by the school administrators at the end of the school year. Informally, however, Nathan did not look to the school administration as a source of support. For Nathan, the school administration did not consider him as “a part of the solution.” He explained that he had difficulty of understanding his school administration’s attitude toward him. He noted “I am logical and I ask questions because I care. I got in trouble because I cared too much.” (N/12/26/05 P.2)

There was a guidance counselor who was responsible to provide help for the beginning teachers by organizing seminars and meetings within the school. In addition to that, she was to work closely with new teachers and help them if they need help. Nathan indicated that even she was “the official first-year teacher counselor” and she seemed “helpful and friendly”, although he was not aware of her existence until well into the second semester. Like school administrators, Nathan did not look to the counselor as a source of support, explaining that there were seven other new teachers at Kent High School that she was assigned to, and Nathan assumed that she was unable to have time to help all new teachers.

Despite all these efforts, or perhaps because of them, Nathan failed to see these formal support attempts as useful, and he instead gravitated to more informal mechanisms.

Unofficial Support

As far as the unofficial support opportunities for Nathan during his first year at Kent High School, Nathan noted “My department definitely got me through. They are very, very helpful, very good for a first-year teacher. You know because they definitely mentored me as a whole and got me through some rough periods” (NM 06/09/06 P.1). Nathan explained that besides Mrs. Moore and his department head, this entire department helped him and offered their help based on the issues that Nathan had during

his first year in teaching. Compared to other departments and science education departments at other high schools, Nathan explained that there was a “closer net” in his department because the department was relatively small and there were eight science teachers within the department. Nathan explained “In our department we eat lunch together every day. And that really meant something because we would interact, you know and so there was a comfort level that made my life little easier.” (NM 06/09/06 PP.1-2)

During the department wide discussions, Nathan realized that many of his co teachers had a traditional mind set when it came to teaching science. Thus, he illustrated: ...there were times that would come into conflict...for instance if my kids are doing meaningful learning I don’t need to have [test] every other week. You know whereas often times, my department--specifically Mrs. Moore--was very traditional in nature and you have to have a test every seven school days. And you know labs are the most part confirmatory as opposed to investigatory, whereas, I tried to do a little bit inquiry with my kids. So, at times I think that may have caused a little friction. (NM 06/09/06 P.2)

Because of the difference that Nathan perceived between him and the rest of the science faculty, Nathan was evidently reluctant to visit other teachers’ classrooms or ask them help for specific challenges embedded in his classroom teaching. Although he thought that watching other teachers would help him to develop practical classroom management styles, Nathan explained “I just didn’t have the time and I didn’t think of it necessary” (NM 06/09/06 P.2). For instance, Nathan believed that watching his mentor teacher’s classroom would not help him since her students were “high level kids” and they had high motivation toward school and learning, and he thought of his students as “low level.” Thus, watching Ms. Moore didn’t seem to be promising to Nathan.

In spite of their willingness to help Nathan, because of their demanding teaching loads, busy schedules, and their extracurricular duties, the teachers in science department were not able to devote significant amounts of time to Nathan. Nathan explained:

...we had eight teachers all of whom were, oh no six of whom were teaching in extended day. So, they only had one planning period. We had teachers that they taught entire day for a semester with no planning period. Their only break was

lunch. So, they had enough to deal with without any ideological differences weren't large enough for them to speak about. (NM 06/09/06 P.2)

In addition to time constraints, Nathan's self sufficient identity prevented him from seeking aid from or cooperating with other teachers. As he explained that he was "pretty confident with [his] teaching and he identified himself as "pretty self-sufficient." (NM/06/09/06 P.3) As Nathan explained:

I think my department as a whole knew that I didn't need their help unless I really asked for it. Now, when I needed it, recognize that I needed it they were there to provide it. But then I was pretty confident, pretty much knew what I wanted to do and how I wanted to handle things. So, they need to be too hands off whereas there are some teachers who are less self-confident that they may need the support, the more conscious effort of support." (NM 06/09/06 P.3)

Nathan purposefully portrayed a self-sufficient first-year teacher image to other faculty members, thus his self-sufficient image limited his communication with others within his department.

Nathan's expectations from other science faculty members illustrated a crucial contradiction. Nathan believed that transition of first-year teachers into the teaching profession required all community members to work cooperatively. For Nathan it was all science teachers' shared responsibility to help Nathan about the specific issues during his first year. For Nathan it should not be solely his responsibility to seek out ways to teach Earth Science in an effective ways. As a first-year teacher, Nathan indicated that it seemed that no one realized that he was a new teacher and that he needed additional help. There were not any other science teachers offering help to him saying "We know you're new, we've been doing this for a while, why don't we help you. Why don't we plan together" (N/06/15/06 P.4)? No one offered to come and watch him, offering advice. Alternatively, Nathan identity seemed to rebuff any assistance.

While Nathan seemed to rebuff offers of help, he seemed to recognize that he was in need of it, and in the future he wanted to "be there" for other first-year teachers:

I know that anytime after next year we have a new science teacher I'll make it to my business to go and talk to them and say "Hey I know you're new, I know you're first-year teacher and it can be very difficult you know and so if you ever

need anything my door is always open to talk for ideas, for labs, for whatever.” And if they happen to teach the same thing that I teach or taught I would say “You know what why don’t you come over and we can talk through some things and you can pick my brain and I’ll tell you some things I think that they really work well.” And ultimately it’s not my business to tell you what to do but I’m gonna tell you what I found successful. None of the other two earth science teachers that taught earth science did that. (N/06/15/06 P.4)

Unofficial Mentor as a Source of Good Motivation

As opposed to his perception about the general science faculty, Nathan viewed his department head, Mr. Clair as an exception in terms of the help he received in the science education program. Although he entered the school year with a dismal vision of the science faculty, by the end of the first semester of his induction year, Nathan realized that his department head was indeed a very good Earth Science teacher. He realized this when he asked his department head for help designing his final exam questions. Mr. Clair’s assistance in this small task opened Nathan’s eyes to Clair’s expertise. Afterwards, Nathan occasionally approached Clair with other issues, “If it is something that is not a complete waste of time I will ask my department head. You know he is so busy and I don’t wanna talk to him and waste his time.” (N/12/26/05 P.2)

Mr. Clair was a veteran teacher who had been teaching science for more than 20 years. Out of his teaching experiences, he spent over 10 year teaching at Kent High School. Mr. Clair was an active member of several of Science Education organizations within his state and across the country. Mr. Clair described his teaching goals as both teaching science and providing his students with “processing the human experiences of doing science.” (M/05/02/06 P.1)

Mr. Clair described himself as an idealistic teacher that he believed “most of the students have a natural curiosity about the world and if you provide them with a set of experiences they’ll improve their understanding of it” (M/05/02/06 P.1). And he explained he felt successful in achieving his teaching goals even within the context of *No Child Left Behind* accountability measures. That said, Mr. Clair understood that it may take a teacher years to see the “payoff” of their efforts, when a student finally decides to

pursue their interest in the science. But he had seen such “payoffs” and knew he was an effective teacher.

In terms of his beliefs about science teaching, Mr. Clair believed “...the idea that we observe the world, try to notice patterns, make a prediction. That type, but it can be whether we’re talking about some very simple things or some very complex things” (M/05/02/06 P.1). Indeed, Clair’s priority was to facilitate students’ development of a sense of scientific thinking whether it was an inquiry approach or some sort of deductive reasoning.

As he appeared to be one of the key individuals with regard to division of labor for Nathan’s first-year activity system, it was beneficial to focus on Mr. Clair’s perception about induction period of science teachers, especially his own experiences during his induction years. As far as his induction experiences, Mr. Clair remembered that his induction year was very less formal than they were currently. Similar to Nathan’s perception about the official first-year support program, even though he was an instructor, Mr. Clair found the first-year program very demanding and “too time expensive for a first-year teacher” (M/05/02/06 P.2). Mr. Clair observed:

...it is almost set up to I don’t wanna say failure but it is almost set up to be too challenging. You know one really...I mean that goes to the retention rate, why so many people after five years aren’t around anymore. Because that first year isn’t a good experience, people tend to then start looking elsewhere or go to graduate school. (M/05/02/06 P.7)

He realized that this induction support program did not provide any substitute for experience. He believed that the current induction program in the district also was not able not support teacher’s practical skills in their classroom, thus he pointed that requiring beginning teachers to go “all these [theoretical] sessions is overkill.” (M/05/02/06 P.2) Therefore, rather than formal induction programs and theoretical support, he argued that use of a mentor teacher seemed to be a more practical and beneficial way to support beginning teachers during their induction years as long as there was a strong sense of dedication and commitment present for the beginning teachers.

Too, Mr. Clair believed that beginning first year teachers were in need of constant support during their first years. And he noted that helping first-year teachers to develop

effective teaching strategies in their first-year teaching was relatively critical for both beginning teachers to stay in teaching as well as the entire teaching community to work with effective new teachers. He noted,

We need good teachers at our school. So, I mean the more good teachers we have the easier everybody's job is. [The] fewer problems he [Nathan] has, you know those create fewer problems for me. I don't have to fix any problems. So, the better teachers we have, it's, I have more free time for myself to do my teaching and my planning. (M/05/02/06 P.2)

For more effective first-year experiences, Mr. Clair pointed out that first-year teachers should have a reduced teaching load "so that they can be effective, so that they can interact, so that they can watch another teacher not necessarily science teachers but any effective teachers who are at the school." (M/05/02/06 P.7)

In terms of his communication with Nathan, it was evident that Mr. Clair used his expertise when he was trying to assist Nathan. Specifically, Mr. Clair perceived that without telling Nathan what to do and how to do, he often attempted to provide Nathan with an account of his own experiences, detailing what worked well and what did not work, and just letting Nathan decide the appropriate course of action. (M/05/02/06 P.2)

Too, Mr. Clair played a significant role in supporting Nathan emotionally when Nathan faced with contradictions. Thanks to his expertise in teaching, Mr. Clair was aware of the difficulties of first year teaching, thus he tried to be supportive of Nathan by "giving him encouraging words when he is down, trying to tell him 'Don't stay down too long. Step up, keep going. It will be better next year.' And it will be. Second year is always easier than the first year" (M/05/02/06 P.2). Mr. Clair tried to encourage Nathan as he understood that it was very easy for beginning teachers to adopt negative attitudes in their professional lives.

Mr. Clair's philosophy was to find something encouraging and positive to maintain positive attitudes in his teaching context. He explained "When we're managing our students we say you know catch them doing something good." Therefore, he tried to approach Nathan similarly. He explained that he looked for the occasions when he heard good discussions and observed student engagement in his classroom and afterwards by the virtue of such experiences, he tried to encourage Nathan by "Hey, I noticed that was

going well today. What're you gonna do next to follow that up" (M/05/02/06 P.4)? Mr. Clair believed "Everybody feels better when you're positively recognized" (M/05/02/06 P.4). Consequently, he tried to approach Nathan through his positive recognition of his teaching practices and strengths.

As far Nathan's specific weaknesses and the strengths during his first year, in spite of Nathan's strong content knowledge in physics, Mr. Clair realized that Nathan's lack of Earth Science content knowledge posed a particular difficulty for him. For Mr. Clair, Nathan's struggle in teaching out of field was relatively a natural feeling for the most beginning teachers. However, Mr. Clair recognized that Nathan was very strong in relating physical science to Earth Science. He indicated that Nathan needed to be encouraged to connect what he knew about physics to Earth Science content that he was teaching. On many occasions, he tried to help Nathan highlight the commonalities between Earth Science and Physical science. Mr. Clair specifically focused on the concept of density and he attributed that with a good understanding and use of density, an Earth Science teacher may effectively explain and teach many Earth Science topics including rock cycle, wind patterns, movement of heat, plate tectonics and ocean currents. Mr. Clair explained that Nathan needed to get comfortable with interconnectedness of science, allowing him to draw on his strengths. And Mr. Clair indicated "Nathan could have gotten to be a little bit closer to that this year than maybe I thought he would have." (M/05/02/06 P.4)

Mr. Clair's assessment of Nathan didn't stop at content knowledge, however, as the department chair emphasized that a teacher should always consider the social aspects of student learning and give them with opportunities to communicate with each other by getting them involved in activities. According to Mr. Clair, in Nathan's classroom students had to passively listen to Nathan and Mr. Clair explained "[Nathan] has resorted to that both because it is preference: he likes to be the deliverer and to talk. And he can be effective at that but [there is] too much of that [in his classroom]" (M/05/02/06 P.6). On several occasions, Mr. Clair suggested that Nathan incorporate more activities in his teaching. Mr. Clair explained "We have boxes of student activities and lab activities to do in Earth Science." Additionally Mr. Clair specified that Nathan could be able to manage to do all of the activities with the present supplies and tools that belong to the department.

However, Nathan did not use them because it required additional planning and preparation as well as requiring a level of classroom management that he had not yet achieved. According to Mr. Clair, similar to many beginning science teachers, Nathan underestimated the preparatory time to teach science, particularly if it is going to be a lab or some sort of experimental process.

Mr. Clair understood that Nathan's lack of emphasis on his teaching resulted in severe management contradictions that led to inevitable failure in his teaching. Mr. Clair explained that Nathan needed to reflect on his first year of teaching and decide what did not work and what did for before starting his second year. He also perceived that Nathan needed to specify at least three teaching goals for his next year of teaching and try to come up with methods to achieve them, rather than "be all over the place." (M/05/02/06 P.7)

That said, Mr. Clair explained that Nathan had made a remarkable amount of growth during his first year. Because of the school's scheduling, Nathan essentially had an opportunity to change his two classes and make another start during his first year in teaching. According to Mr. Clair, this was one of the benefits of the Kent High School's scheduling policy. Based on his observation, Mr. Clair stressed "there was tremendous amount of growth between [Nathan] started in August and how he started with these two new classes in January" (M/05/02/06 P.3). Mr. Clair explained that it was encouraging that Nathan seemed to be more willing to "take chances or risk with new lessons or alternative kinds of teaching" whereas many beginning teachers do not attempt to make changes. (M/05/02/06 P.3)

Besides his department head, Nathan also recognized that his mother and some of his friends from graduate school also provided other support for him during his first semester in teaching. To overcome the problems that he faced during the year, to share his experiences and get advice, Nathan often communicated with his mother, who was an experienced Spanish teacher. Additionally, he indicated that talking with his friends, his major professor and me also helped him during his induction year. He liked to be listened to by others and valued for his ideas. Those were the moments that he felt comfortable to talk about his experiences during his first year in teaching.

This Research's Contribution to Nathan

Nathan stated that it was very rare that a beginning teacher can find somebody who is impartial to talk with during the first year. Nathan perceived me as someone to share his experiences. He noted,

...whether I was right or wrong with the whole situation I created for myself, you were on my side. Even though I probably did it to myself, you were on my side and something like that. Somebody you can just go to once every couple of weeks and just be like “This is what has sucked!” But at the same time this is what has been good. Kinda like flush your system of all of the conflicting things.

(N/06/23/06 P.13)

Thus, Nathan perceived that our conversations played important role in helping him negotiate his first year in teaching.

Rules

In the framework of CHAT, rules refer to the explicit or implicit regulations that constrain actions, written or unwritten rules (Kärkkäinen, 1999). In Nathan's first-year activity system, the rules that he acknowledged mainly included the norms and expectations of the Kent High School community. For Nathan, there was a lack of community involvement in rule-structuring process. Because of the historical and cultural background of the school, it seemed that the school administration was in charge of defining the necessary rules. As far as community involvement, there was a lack of community involvement in the rule making process. It seemed that the school administration was in charge of deciding what is necessary and what needs to be done by whom. To inform the entire school community about new rules and implementations, the administration used faculty meetings. Although the administration invited other community members to make their inputs in decision-making process, for Nathan teachers' voices were not heard by the administration. The following section will explore the rules of Nathan's first-year activity system and how Nathan perceived these rules and how these rules interacted with Nathan's first year experiences.

Norms and Expectations of Kent High School

As discussed earlier, Kent High School was an urban high school with a significant number of minority and low SES students, a history of low test performance, and an administration that was largely focused on this performance. Because of its contextual realities, the school generated a difficult context in which to generate effective learning experiences for students. Mr. Clair explained that unlike the teachers at other schools, teachers at Kent High School had to spend a lot of time and needed to go through a complex procedure to address discipline problems. According to Mr. Clair, Kent High School was “too accepting of disruptive and poor behaviors” (M/05/02/06 P.4). Consequently, the school created a climate where disruptive and poor student behaviors were accepted.

Given these contextual realities, it was increasingly difficult for teachers to focus on teaching and learning activities because of students’ behavioral and motivational problems. That said, Mr. Clair indicated that most of the teachers at Kent High School were successful and “good people” in terms of dealing with students. However, teachers sometimes had issues with administrators who were not successful and experienced teachers. According to his perception “an effective school boils down to a strong principal and strong educational leadership.” However, for Mr. Clair, Kent High School did not have this sense of strong leadership. Because of the poor management of Kent High School, for Nathan it meant a “struggle to teach at Kent High School every day”. (N/11/18/05 P.4)

In a larger scale, the lack of leadership and management of the school administration created several other contradictions and fundamentally hindered the collaboration within and across the departments. Most critically the school community generated low expectations for students.

As far as beginning teachers’ adaptation of the school context, the school expected all teachers including beginning teachers to pursue these goals during their curricular practices. Through his internalization of the general Kent High School activity system, Nathan understood “the norm [of Kent High School] is to conform, expectation [of Kent High School] is to confirm.” (N/12/02/05 P.3) By pointing to the school

administration, Nathan illustrated that the school administration “very much look down upon teachers” and the administration wanted teachers to conform.

As far as the expectations from Nathan as a beginning teacher, he perceived that there seemed to be an inherited “culture among a lot of teachers that by virtue of being a first-year teacher, I don’t have any idea what I’m talking about.” (N/12/02/05 P.3) Since he had not taught for a full year, Nathan perceived that many teachers believed that he could not have an opinion.

However, Nathan found this judgment unfair, thus, he noted “I do have an opinion” and “by virtue of the fact that I’m 24 and when I was in high school I shared a lot of characteristics with a lot of our students.” (N/12/02/05 P.3) And he described that he was not a successful student, and similar to many of his students, he was not motivated to do well in school, and he did not do well in high school. Therefore, for Nathan, his opinions were valid but most of the teachers believed that as a newcomer his arguments were invalid.

Although he disagreed with this notion, for his next year teaching in terms of his participation to the school community, he envisioned himself to be careful about expressing his ideas, and he indicated that he would prefer to be silent during the faculty meetings. And Nathan noted, if he were to give advice to a beginning teacher, he would say,

For the first 6 months I probably won’t say anything to anybody until I’ve got an idea of the school, and who talks and who doesn’t talk. And if anybody asks me for an opinion other than maybe like my department chair I’ll probably just be like “You know I haven’t really given much thought to that. I like more time to think about it.” (N/06/23/06 P.4)

Therefore, Nathan noted “And so next year I, for the first semester I ain’t talking to anybody about anything. I will not complain about things. Everything that my school does is gonna be wonderful” (N/06/09/06 P.4). Additionally, he also realized that it would be beneficial for him to preface his opinions through stating that this is his second year in teaching.

As far as the common culture at Kent High School, Nathan specified that the source of these norms and expectations were consequences of an “implicit cultural

evolution” at Kent High School. (N/12/02/05 P.3) From purely an evolutionary stand point of culture he perceived:

...these teachers possess these values were at my school longer than teachers that didn’t posses these values, maybe because our administration possesses these values. And so teachers had the same value are able to get along with the administration better than teachers that don’t have these values so that the teachers don’t have the values leave. (N/12/02/05 P.3)

And after couple of weeks in teaching being exposed by this evolved culture, Nathan realized “reality shock” and acknowledged an “I am not able to save the world” point of view as a reform-minded induction year teacher. (N/12/02/05 P.3) Evidently, the current culture of Kent High School powerfully influenced Nathan’s idealism that he developed during his preservice years in relatively short time.

During the adaptation period of learning the norms and expectations at Kent High School, no one introduced the specific school culture to Nathan. It was because of his self-sufficient portrait that he represented during his student teaching time, the entire Kent High School community had no doubt about his adaptation. His learning of the school culture as a professional work place was not an easy period for Nathan. Since there was no one to help him to learn about the official and unofficial norms and expectations Nathan noted:

I learned by trial and error...that they don’t want to hear what I have to say and I learned that because when I said what I had to say, they didn’t listen and didn’t like it, they almost fired me. I’ve learned don’t ever give an opinion in faculty meeting. (N/12/02/05 P.4)

An exploration of teachers’ overall perceptions about the faculty meetings illustrated that faculty meetings were not something that most of the teachers willingly participated in.

Similar to Nathan, there were also many other teachers who were reluctant to go to faculty meetings because of the school administrations expectations from them to conform. And many veteran teachers including Mr. Clair, his department head and a National Board certified teacher, went to meetings since it was required, and their participation did not go beyond asking only clarification questions. He perceived “they

know the repercussions for having an opinion different from our administration.” Except for those who did not like to conform, the rest of the teachers who were members of “inner circle of teachers” never disagreed with the administration but conformed to what the administration articulated. (N/12/02/05 P.4)

After his internalization of the culture of Kent High School at faculty and administration level, Nathan regretted that he did not realize this culture during his student teaching period, since his learning of the school culture was an explicit struggle for him. He perceived that this culture dictated by the administration prevented teachers from being able to “see the holistic picture.” (N/12/02/05 P.4) Thus, generally each teacher had his/her group of teachers, and they mainly communicated within their group. In short, for Nathan, “being a part of the Kent High School community feels bad.” (N/12/02/05 P.4)

In a relatively short time in his first year, Nathan realized that Kent High School was not a school where he was accepted as a professional, but rather as a newcomer. Thus, this perception generated an emotional dispute for Nathan; it also restricted his communication with other community members to generate fruitful learning opportunities for Nathan.

Other Official Rules and Regulation

Just as in many other districts and states, there was remarkably little room to negotiate salary for a first-year teacher, although Nathan did try when he first accepted the position. That said, there were some incentives and perks that the district provided for all teachers. One of the incentives was one hundred dollars, “teacher lead money.” (N/12/02/05 P.10) The purpose of this financial support was to support teachers’ instructional practices by giving them opportunities to spend this money for the necessary supplies and tools that they needed. Nathan used this money for purchasing office tools. Another incentive that the district provided for teachers was “teacher education funds” to support teachers’ participation in professional development activities. (N/12/02/05 P.10), and the district paid for Nathan’s trip to the National Science Teacher Association conference during his first year.

Nathan's Classroom Rules

To facilitate and maintain an effective learning environment, Nathan attempted to employ two different sets of classroom rules. The first set of rules defined the regulatory activities that students should be aware of during the classroom activities. The second set of rules, in turn, aimed to let students know about the consequences if any of his students failed to follow the first set of rules. Nathan placed the rules, shown below, on the front wall of his classroom so that they were in clear view.

Table 5.2: Nathan's Classroom Rules

Classroom Rules	Consequences
1: Respect	1: Infraction (verbal warning)
2: Be in seat when bell rings	2: Second infraction
3: Be prepared for class	3: Third infraction (30 minutes detention and call home)
4: Do not talk out of turn	4: Fourth infraction (An hour detention and call home)
5: No cell phones	5: Fifth infraction referral to the office and call home
6: Follow all school rules	
7: Follow all lab rules	
8: No cheating	

However, in practice, Nathan seldom followed up on these rules. Rather than trying to make sure that these rules were in practice, he consistently ignored these rules at the beginning of the school year, focusing more on gaining a strong sense of student rapport. He indicated that he cared very much about his students, and he liked to create a mutual relationship between him and his students. Indeed, his strong sense of care and overemphasis on maintaining good student rapport dominated his primary teacher identity. Nathan specified that his students did not view Nathan as their teacher. Because of the way he represented himself to them, he felt that his students viewed him as their friend to talk about their private lives. Nathan noted,

I know which of my students have sex; I know which of them drink, I have ideas which of them do drugs...and it's not good. And so when they tell me these things I'm not their teacher, I'm their friend. And it is very difficult to transition from

friend to disciplinarian...I like that they come to me but at times then that that conflicts with the fact that I'm their teacher. And they don't always see me as their teacher. (N/03/01/06 P.10)

Indeed, the situation became a severe management concern in which Nathan's even limited attempts to teach Earth Science and Astronomy content became his secondary concern. He noted "...the division between student and teacher was blurred maybe more than it should have been. That doesn't mean that there was inappropriate relationship but it was not strictly student-teacher." (N/06/15/06 P.5)

In practice, Nathan tended to ignore students misbehaviors for a time, followed by raising his voice when students got "out of hand." His lack of emphasis on classroom management quickly caused Nathan to "lose control" over the class at the beginning of the school year. Nathan reflected on this pattern at the outset of his second semester. Some of his students brought contraband to his class. Nathan realized that his students probably thought that he wouldn't object because of his "relaxed" management style. He realized that he needed to take serious actions to address students' misbehaviors and he said "that's my job, that's my livelihood." (N/02/13/06 P.4).

This event caused him to become more aware that beyond his need to create and maintain a strong sense of student rapport and loyalty, he needed to position himself as "the teacher" and he recognized that his primary role was to facilitate a well-managed learning context where teaching and learning had to be the primary concern. Thus he noted "...eventually continual non dealing with issue gets the point where I become so frustrated that it just all boils out at once. I am not [a disciplinarian]; I can't do it for some reason." (N/09/17/05/ P.6) As we discussed earlier, his identity as a friend of his students may have prevented Nathan from invoking his classroom rules since he did not want to lose his student's rapport as it was a source for external validation for him. Or, perhaps, his relaxed management was derived from his own schooling history. During his high school years he wished that his teachers would have treated him as an adult. Nathan explained:

I always thought when I was in high school that there was a better way to do it instead of being just a jerk. And so my assumption was that they are old enough that they can handle the freedoms that I wanted to be given when I was in high

school and still learn. And so, you know I set up a situation where learning was not fostered. I'm not saying that that's impossible to do but I won't do it as I did last year. (N/06/15/06 P.5)

Likewise, Nathan indicated that it was one of his goals to treat his students as adults. However, he noted "But they're kids, they wanna push and push. You know, I can't manage the class. I can, but I can't. And part of it is that I student-taught with eleven graders, now I am teaching ninth graders." (N/02/13/06 P.4)

Nathan sometimes had difficult times with his students, and he had to get help from the school administration. One day, after the class started, one of his female students seemed to be nervous. And he asked the reason and took her outside of the classroom to talk about her problem. While they were talking, one of his male students walked outside of the classroom, and Nathan asked him to go back into classroom. The student refused. The problem escalated, and Nathan decided to take the issue to the main office. He asked another teacher to watch the class while he was took the offending student to main office.

Here we see that Nathan created the situation to an extent where it became difficult for him to manage his classroom time as well as his students' behaviors. In this example, rather than talking to one of his students out of the class time, he uses his class time to talk over his student's personal problems. An examination of classroom observations illustrated that Nathan seemed to spend a significant amount of time talking with his students about their daily lives. Too, it was evident that because of block scheduling and his lack of content knowledge as well as his lack of preparation for his teaching, he preferred to use his classroom time for social and political issues rather than the content.

Nathan's lack of classroom management and his student friendly identity appeared to be a significant contradiction in his activity system, one that was in need of attention if he were to learn to teach effectively. His ineffective classroom management was even clearer in his Astronomy class compared to his other classes.

As opposed to his Earth Science teaching, Nathan expected effective teaching and learning activities in his Astronomy class based on his strong background in Physics. In addition to his strong content knowledge in Astronomy, he thought that most of his

students in the Astronomy class were seniors and Nathan thought of them as adults that could take responsibility for their actions. However, he stated that because of the context that he created with this approach, “there was little learning going on for multiple reasons” in his Astronomy class. (N/06/15/06 P.5) Observations in this class revealed his students’ talking with their friends by their cell-phones, eating as well as going in and out during the classroom time without restriction.

Before he started teaching Nathan refused to accept a traditional management approach, which he defined “it’s better to start off tough and get nice” and he thought that maybe “there is a legitimacy to that.” (N/02/17/06 P.3) Rather, he initially aimed to create a strong relationship with his students by structuring a relaxed environment in his classroom. However, Nathan realized that his students “took the advantage of that,” and he had issues with his students during his second semester at Kent High School.

(N/06/15/06 P.5) He perceived that there were other ways to “get along with students” and “have fun without creating a situation” where “learning cannot be done.”

(N/06/15/06 P.6) He noted that in order for him to effectively teach students with a lack of interest in science and learning, he needed to treat them differently. He described himself as not being a “disciplinarian” teacher, and he realized that he needed to develop new strategies to overcome his classroom management problem.

Nathan tried several practical remedies to his management woes. He became very proactive in preventing some of his students’ possible misbehaviors in his fourth block Earth Science class. He started watching them more closely. Rather than treating the entire classroom the same, Nathan focused on individuals and their misbehaviors. Nathan expressed:

I got a kid who very much has the same attitude in my fourth block as in my first block. And I yelled him daily, daily. And I hate yelling at him. But I do it because if I don’t yell at him, it is gonna make it so my other kids can’t get the experiences that I want. And that is fine. I pulled him out of a lab last week. We did a lab where they took the soda can and they put water into the soda can, put it on a burner, take it immediately after the burner, and dunk it in ice water. And the can crashes. He took some water from a pipet and squirted somebody down the back of their shirt. So they jumped. These kids are dealing with the burners with

100 degree. I looked at him and say “Do that again, you’re getting a zero from the day, and you’ll have to make this lab up after school.” I go and another group needs my help so I go to help them. I turned around he did it again. I said “let’s go” and I brought him to another teacher’s room. I said do not move till I come, get you.” (N/02/03/06 P.14)

Looking back at his first semester, Nathan wished that “I would not have permitted them to get out of control the way I did. I would have written referrals much sooner.” (N/02/17/06 P.3) For his next year, he realized that he needed to be “stricter” in terms of defining and posting his rules and consequences and be consistent to applying what was required in his classroom management. (N/06/15/06 P.1)

Significantly, Nathan also realized that because of his attempt to create a “relaxed culture” in his classroom during his student teaching period at Kent High School, he gained a reputation among the students that he could not change easily. However, he assumed that in his new school, he would not have the same reputation so that he could be “free” to build a culture where teaching and learning would be the main focus in his classroom (N/06/15/06 P.5).

Mediating Artifacts

Many argue that there are two types of mediating artifacts in an activity system being investigated: tools and signs (e.g. Claxton, 2002; Engestrom, 1999; del Rio & Alvarez, 2002). Leiman (1999) outlines that tools and signs significantly differ from each other although they both play significant roles. According to Leiman, signs and tools as mediating artifacts function in a very different way in a system of activity. Simply put, in the discourse of an activity system, tools arbitrate object-oriented activity, whereas signs, mediate social interaction in the form of language within the activity system.

Thus, in this section, we will explore both tools and signs as crucial mediating artifacts for Nathan’s first-year teaching context to better understand how these mediating artifacts helped or hindered Nathan to become a competent member of Kent High School as well as the impact of these mediating artifacts on Nathan’s first-year science teaching practices mindful to science education reform.

Classroom Context

This section explores Nathan's specific classroom setting in terms of its physical condition and other related instructional instruments and supplies essential for teaching and learning science.

Physical Space and Material

The classroom had one main entrance and another exit doors located at the back side of the classroom for Nathan to access the teachers' room. The teachers' room was actually a hall where teachers stored their belongings and laboratory equipments. At the entrance side of the room, Nathan's classroom had a relatively large chalkboard that had four separate portable sides. On the top of the chalkboard, Nathan quoted "The decisions we make dictate the life we lead." In front of the chalkboard, Nathan had a wall to wall counter, used by Nathan as his main desk and demonstration table if there was not enough space for student to do activities. On his desk, there were papers, chalk and three dolls that Nathan used to track his students restroom trips. Since there were only three toys, only three students were allowed to take timeout at a time. Besides the toys, Nathan used a sign in notebook to track his students' timeouts.

Although his classroom lacked most of the essential materials and the supplies to facilitate activities and labs, the science department had an abundant amount of materials to facilitate teachers' Earth Science activities. In terms of the practical help for Nathan within the department, since Mr. Clair had a profound amount of teaching experience in teaching Earth Science, he attempted to help Nathan with activities, lesson planning and some content approach. Specifically, Mr. Clair provided Nathan with various different documents, activity kits, lesson plans to teach Earth Science effectively. However, Nathan found these materials unclear and he claimed that he did not have enough time to review them and understand them. Thus, Nathan noted "I knew I didn't have time to try it out, which is unfortunate but if I couldn't visualize what was gonna happen and what should happen in my head, I didn't want to use them." (N/06/15/06 P.4)

The classroom space was not adequate for around 30 students in each class. The classroom had more than 30 chairs around the classroom, all of which faced toward the frond side of the classroom. Students were seated in four rows. The distance between the

rows was narrow. Besides these chairs, there were four tables at the back side of the classroom. These tables helped Nathan to facilitate experiments. Besides these four tables, there was another wall to wall counter located at the entrance side of the classroom.

As far as the organization of the classroom, during his entire first year, the room was unorganized for teaching and learning. In terms of the description of the classroom arrangement, including whether the arrangement inhibited or facilitated the interaction between teacher and students and among the students, the arrangement of the classroom was useful for teacher student communication. However, interaction among students seemed to be inhibited by the arrangement of the classroom since students were seated toward the front side of the class, and it was difficult for them to see and communicate with each other. Additionally, while students seated in front of the classroom could easily see the board, students in the back side of the classroom did not have an easy view of chalkboard.

Thus, Nathan identified the physical environment as a crucial inhibiting factor in his teaching context obscuring his reform-based practices. He noted:

The physical environment does not make it easy at all. I don't have outlets, I don't have gas, and I don't have lab benches. Next semester, in my new earth science class, I will have thirty three students. Thirty three, they are going to sit so cramped, and they are going to sit seven rows deep. And they're gonna need binoculars to see the board. You know how am I gonna do labs with 33. It is impossible. (N/12/26/05 P. 2)

Indeed, Nathan cited the lack of physical space and materials has prohibitive to reform based teaching practice.

Textbook

At the beginning of his first year, the science department provided Nathan with an Earth Science textbook that the school used previously. Along with the textbook, the department also gave Nathan a curriculum guide on how to cover the content in the Earth Science textbook. As far as his perception about the curriculum guide, Nathan believed that the curriculum's guide was irrelevant to grade level expectations outlined by the state

standards for Earth Science. Based on the curriculum guide, Nathan thought that he would be covering only a limited numbers of the grade level expectations. Thus, he decided to make major changes for his second semester Earth Science teaching based on his first-semester experiences. According to his experiences, Nathan planned to “restructure [the curriculum guide] and might start with Astronomy.” He also envisioned himself extracting some of the sections in the curriculum guide that he perceived as not significantly important. (N/11/11/05 P.7) However, during the following semester, he was not able to apply his plans because of the extra demand that he perceived on his teaching. Rather, he used the same structure that his department provided him, with minor changes.

As far as the Earth Science textbook, similar to his perception about the curriculum guide, Nathan also did not find the textbook relevant to the grade level expectations. While he did not have a textbook for his Astronomy class, Nathan used a textbook for his Earth Science classes. There were approximately 30 textbooks in his class and students were allowed to check them out if they need to use them at home. It seems crucial to point out that during the entire school year, none of the students checked out the textbook to take it home to study.

As far as Nathan’s thoughts about the textbook, at the beginning of the school year Nathan believed that the textbook covered most of the standards. However, it was during the first term of his teaching that he realized that the textbook did not align with the standards. Specifically, for 9th grade Earth Science class, as the majority of the standards were Astronomy-based, and there were 13 expectations that Nathan was supposed to cover within a semester. He indicated “Out of those, 7 of them are astronomy, which means you’ve got some oceanography, some weather you know, some Geology.” (N/11/11/05 P.7) Besides, the textbook also covered sixteen chapters on Geology and ironically “there is [only] one Geology standard” specified in the grade level of expectations. Consequently, Nathan indicated that there were only two state standards covered in the entire textbook. (N/11/11/05 P.7) Therefore he specified “...our book doesn’t necessarily even align with the focus of the standards, the grade level expectations. But they probably chose this book, because they thought that it was the easiest in terms of the using the book tests.” (N/11/11/05 P.7)

In addition to its lack of alignment with the state expectations, for Nathan, the section reviews and questions as well as activities in the textbook were also “irrelevant” so that he was not able to relate them to his teaching. (N/06/15/06 P.5) Similarly, Nathan also realized that the textbook did not align well with the reform implications. For Nathan, although the textbook had some beneficial activities, he explained that the design of the book was very traditional and activities were placed at the end of the sections. Nathan believed that to better implement reform implications, activities should come at the beginning of the chapter. And because of time concerns, he explained that he was not able to search the book in advance for an effective activity to facilitate in his teaching.

When there was some important information that the textbook did not cover or perhaps his lack of Earth Science content knowledge restricted his understanding of a particular section, Nathan occasionally attempted to facilitate outside sources to teach that particular content. He indicated:

...we’re doing the interior of the earth. And there is nowhere in the book where it goes through the layers of the earth. Our textbook doesn’t talk about the core, doesn’t talk about the crust. So I had to bring that content from another source end of the class. So we don’t have a textbook, which I am hampered. I don’t have time to write work sheets, and I don’t wanna give them questions from the book that make them synthesize different parts of the book. Or, I can give them, you know, the book sometimes ask questions that I just don’t think that they are important. So what do I do, I gotta waste class time going over it so I can give them some homework. (N/11/11/05 P. 6)

By the end of the school year, Nathan informed his department head about his concerns about the book. Apparently, Mr. Clair agreed with Nathan, and he decided to change the Earth Science textbook for the following year. Thus, Mr. Clair invited Nathan to the selection of the new textbook. However, Nathan did not want to be a part of the book selection process. He explained “I am not gonna be back at my school next year [and] I am not gonna waste my time reviewing materials that I hope I don’t ever need to teach from because I need to teach physics.” (N/06/15/06 P.5)

As an outset of his first-year teaching experiences in terms of his use of curriculum guide and textbook, Nathan’s lack of content knowledge in Earth Science as

well as the limited effort that he put into his teaching prevented Nathan from using textbook and the curriculum guide effectively; rather, for Nathan both the textbook and the curriculum guide seemed to be the sources of contextual discontentment during his entire first year.

Technology

The science department was relatively “technology poor” and Nathan’s classroom was not an exception. As far as the technological supplies available in his first-year teaching context, Nathan had only one computer located at his counter. During my visits to his classroom, although the computer was for Nathan to aid his planning and instructions, students seemed to be reasonably comfortable to use the computer to check their emails, surf on the internet as well as listen to music.

Additionally, his classroom had four outlets, but among them only two of them had an easy access. In spite of their existence, three fume hubs located at the corners of the classroom seemed not to be in use for a long time, they were relatively outdated. Nathan did not have an overhead projector. Nathan suggested that the lack of instructional technology available in his teaching context prevented him from enacting many essential activities during his first year. For example, during a unit on graphing, he had to spend considerable amount of time for “graphing, analyzing, and finding patterns” of specific set of data. (N/11/11/05 P.9) Nathan noted that if there was appropriate technology in his classroom, he would not have to spend a lot of time for such activities, rather he could devote more time on students understanding of the content.

Indeed, lack of instructional technology became a real crisis in his Astronomy class. As opposed to his Earth Science classes, Nathan did not use a textbook in Astronomy so that it was quite difficult for him to facilitate visual representations--staples of this course. Nathan had to hand-draw any visual explanations he employed in Astronomy. This limitation presented a serious problem in this course.

Curriculum and Achievement Test and Standards

As discussed earlier, there did not appear to be a shared vision in the school concerning the education of its students. For Nathan, the biggest concern of Kent High School community was to “make all our kids better” in the state achievement test, but he

added “There is no real common vision on how that is done.” Nathan noted that the state achievement testing “screws our school” because all faculty members were under pressure given the historically low performance of its non-mainstream population. (N/12/02/05 P.2) Indeed, the school administration’s decisions to foster student achievement in the state test seemed to generate isolation among the departments as well as teachers rather creating a sense of community of practice.

The school administration understood one of the most pressing needs was for the students to do well on the state achievement test. Given the urgency of this need, the administration tended to make short term decisions. For more than four years in a row Kent High School’s grade in state achievement test was a “D”. Nathan indicated that “Maybe for our administration if we don’t pass the achievement test this year there is no next year. Their concern was to get us pass the [State’s achievement test] right now.” This need became an explicit focus of many faculty meetings. According to Nathan, the school principal said “maybe we need to stop teaching a lot of material topically and start teaching little material in depth.” What Nathan understood from his principal this suggestion was “I want you to teach to the [the State achievement test] and that is it.” (N/11/18/05 P.3)

For Nathan, teaching for state achievement test presented a contradiction. Nathan noted “[The achievement test] is not why I became a teacher. And [the achievement test] would tell you that that is not what you’re supposed to do, you aren’t supposed to teach to the test.” (N/11/18/05 P.3) Nathan specified “I am supposed to teach [the state standards] and I am supposed to teach them so [students] can pass the state achievement testing.” (N/12/02/05 P.6) Nathan indicated that current standard-based culture at Kent High School also contradicted his teaching philosophy. He noted “...my teaching philosophy is very idealistic...talking about dreams” whereas, the school was “...not inspiring students to anything.” (N/12/02/05 P.8) As an idealistic first-year teacher, Nathan wanted to inspire his students to “greatness” but the school wanted to mandate passing the state achievement tests. This created A contradiction where he underwent overwhelming pressure with his low level students who needed to pass the test. While the entire school was trying to help low level students to pass the state achievement test, Nathan also

perceived that this urgent demand on achievement in testing caused entire school community to ignore high level, well achieving students. (N/12/02/05 P.8)

Nathan believed that the test “drives everything that happens” in Kent High School. (N/12/02/05 P.6) Because of the overwhelming emphasis on testing, Nathan explicitly understood “... [State achievement test] makes everybody miserable. The kids come up with this idea that the only thing that matters about high school is the test...and if [students] can’t pass the test, they are dumb.” (N/12/02/05 P.6) The current situation evidently frustrated Nathan, placing him under additional pressure during his induction year.

Socialization

Within the CHAT framework, many conceive cognitive development not as taking place within individuals’ minds, but rather through the processes involved in contributing to jointly undertaken activities (Hasan, 2002; Nonaka & Takeuchi, 1995; Pontecorvo & Sterponi, 2002). However, the social structure of Kent High School illustrated that there was not a profound sense community of practice in terms of both social and professional vision among the members of the school. Thus, as far as his socialization with other community members at school, Nathan had limited amount of socialization opportunities during his first year.

At the beginning of his first year, it was Nathan’s hope to participate in a strong collaboration among teachers at Kent High. As far as the social structure of the Kent High School, Nathan understood that it was “a very compartmentalized school” (N/12/02/05 P.1)

Teachers at the department welcomed Nathan to their small community and offered their help. Among others, Mr. Clair, department head, provided exceptional socialization opportunities to Nathan during his first year. When Nathan first became a member of the department, Nathan became part of the “lunch crowd”, and indeed this group of 5 teachers began meeting in Nathan’s room for their lunch. Nathan was quite happy with this opportunity given to him by his department. He noted:

...my department eats lunch together every day so we kind a just throw things back and fourth. If I am having trouble, I can always go to my department head

that he is very, very, very helpful. You know I have few teachers that I am kind of OK within the program. (N/11/18/05 P.8)

During the second semester of his teaching, the school administration appointed Nathan for a lunch duty. Although the duty required Nathan to spend his lunchtime at the cafeteria, the science faculty continued to meet in his room.

Although this paints a rosy picture of Nathan's interaction, it is important to note that Nathan's socialization with them was limited to these lunch breaks. During his first year, except for a few occasions, Nathan did not ask any help from faculty members. Mr. Clair expressed that Nathan did not watch any other faculty members' teaching during his first year at Kent High School. However, according to Mr. Clair, this was not unusual and most of the time beginning teachers tended "to look at something down the road and they focus on that and they don't see what is right in front of them." In Nathan's case, Mr. Clair explained that Nathan was very "tied up and looking down the road in his professional career, completing his graduate work, and possibly going on for more graduate work." (M/05/02/06 P.5) Therefore, Mr. Clair believed "when your focus spreads out, it does reduce your effectiveness." (M/05/02/06 P.6). Although he respected Nathan's enthusiasm toward his graduate studies, Mr. Clair believed that it should have been Nathan's priority to focus more on his teaching so that he would become more effective in the future. Based on his observations, Mr. Clair indicated that Nathan decided to give more time for his graduate studies than to his teaching. In order for Nathan to be a more effective teacher, Mr. Clair stated that he would discourage Nathan from continuing his graduate program the following year.

Mr. Clair also pointed out that Nathan or any first-year teachers would experience similar socialization problems at any school. In Clair's view, Kent High School was not extraordinarily difficult. However, Mr. Clair specified that there were some problems specific to Nathan's identity that caused his first year to be even more difficult. His tendency to share his ideas, but not gain from others in the school, caused some of Nathan's socializations difficulties.

As far as his socialization with other community members in the school, Nathan perceived that many of the teachers did not like him because of his outspoken nature. Nathan was sensitive to this, and he often felt apart from the professional teacher

community, and he preferred to socialize with students as well as the school staff rather than other teachers. Thus, his planning times were often spent in the front office, talking with the staff and student workers. He was well liked by the staff and was comfortable with them.

Nathan also had close relationships with a few of his students. While many of his students enjoyed Nathan's company and his relaxed management style during and after his classes, some of his students seemed to be skeptical about his sense of socialization with his students. There was time that his students called Nathan racist because of his close relationship with a group of students. Too, his socialization with his students became a question to the school administration during his second semester in teaching. As his evaluation requirement, Nathan needed to fill out an ethics form with school administration. One of the school administrators indicated that there some people brought up a concern that Nathan had inappropriate relationships with his students and the administrator asked him for clarification.

Nathan indicated that his relationships with female students were identical to his relationships with his male students, and he noted that he did not treat any of his students differently than any others. Nathan also expressed that he cared about his students social lives and he explained "when they're upset I want to help them not be unhappy." (N/02/03/06 P.1) After listening to Nathan the administrator noted "Well I would agree but you know perception is true in the eye on the beholder. So you need to try to tune it down." (N/02/03/06 P.1)

Until this event, Nathan was spending all of his planning time at attendance office talking with staff and students. He realized that the school administrator did not approve how he used his planning period. Nathan explained "I don't care. If you think that I don't use my planning period correctly you should say "Nathan, I think you need to make better use of your planning period. We don't pay you to sit here and talk to students." (N/02/03/06 P.1)

After the administrator's warning, Nathan started spending his planning time in his classroom and he realized that his planning time became more productive. However, Nathan argued that the administration called for this change, not to make Nathan more productive, but because they did not care for him. He noted "[the school administration]

doesn't like me because I sit there and talk. I talk politics with my students. They don't like me because I know about as much about government and history as their history teachers do." (N/02/03/06 P.5)

Nathan thought that the school administration's and faculty members' approaches to such events were professionally improper. And he explained that it was a constant culture at Kent High School that the administration and other teachers did not hesitate to inform students and other faculty members about private faculty information. Nathan illustrated that there were a couple of incidents that his students came to him and asked him why some other teachers "don't like you." Nathan responded them

...we differ on our views on how best to confront the challenges that Kent High is confronted with, how to answer our problems, how to solve our problems. And sometimes that leads to some heated discussion...Because we have differences; I am vocal because some teachers feel that as a first-year teacher I don't have a right to be vocal. I disagree with them, but that is their business. (N/02/03/06 P.1)

Nathan indicated that it was because of the school's unprofessional approaches to young teachers, he would be the sixth Earth Science teacher in a row who left the school after teaching only one year.

Despite the department head's invitation for Nathan to teach the following year at Kent High School, by mid-year, Nathan had already decided to leave Kent High School. Nathan realized that some of his students and their loyalty to him would make it difficult for him to leave. Just to keep his good relationship with his students, Nathan almost wished the school administration would fire him so that he could explain to his students that the reason he was not returning was the school's administration and not his own personal choice.

Therefore, it was quite evident that both contextual and personal aspects of Nathan's first-year activity system had a great impact on Nathan's first-year socialization at Kent High School. Nathan realized "...you are product of your environment". (N/02/03/06 P.15) Although many of his socializations became a contradiction within his first year, Nathan became more aware that his experiences at Kent High School were very precious and unique and that he may not get the same learning opportunities in "a better" school. Consequently, Nathan explained "I am a better teacher now than I would

have been without this experience.” (N/02/03/06 P.15) Additionally, because of his better understanding of the influences of contextual realities of school, he realized that there were “no easy answers for the questions in educational system.” (N/02/03/06 P.15) Thus, Nathan thought that he would flourish in a teaching environment where teacher input was valued and teachers received administrative support.

Other Mediating Artifacts

To better understand the components of his first-year activity system, Nathan’s lesson plans, tests, homework assignments also provide a significant account of his first-year experiences. During his first year at Kent High School, Nathan did not use any sort of lesson plans (formal or informal) to guide his teaching. For his Earth Science classes, Nathan used the curriculum guide provided by his department and simply outlined what he was going to talk about before each class. As far as the official requirement for his planning, for each class, Nathan simply wrote down the section of chapter name. In support of these lectures, Nathan used his book as the main source for hand outs. During his preparation time, he copied the important practice examples, section reviews from the textbook, and handouts for in class activities. As far as the exam questions, Nathan used his department head’s exam questions, which were multiple- choice in nature.

As opposed to his Earth Science teaching, since there was no textbook that Nathan used for his Astronomy class, he did not use any in-class activities during his astronomy teaching. Likewise, instead of relying on a book or curriculum guide to direct his flow of content, Nathan simply selected the content he would address from those topics he personally enjoyed. Usually, he outlined his lecture right before his class. Given the lack of formal structure, it was not unusual to see Nathan spending four weeks for a single topic. As a result, students often found his teaching redundant, and they questioned his effectiveness as a teacher.

Summary

Nathan’s first-year experiences in teaching were relatively difficult and challenging. As an evaluation of his first year in teaching at Kent High School, Nathan noted “I had considerably larger challenges than other first-year teachers.” (N/06/15/06 P.2) Indeed, the vast amount of these challenges that Nathan perceived originated from

the school's long-time failure in the state achievement test and the administration's emphasis to increase the achievements test scores interacting with his own teaching identity and teaching practices.

For Nathan, the general characteristics of the students also contributed to his ineffective first-year experiences. He specified "I'm teaching in a D school. I'm teaching the lowest ability of the students." (N/06/15/06 P.2) Nathan noted:

I have the lowest [achievement test] scores in the school. You know I have got kids that are in 9th grade and only in school because they're court ordered. The judge gives them the choice: you either go to school or jail. Which would you prefer? Well obviously everybody is gonna go to school. But I mean my kids sell drugs, my kids did drugs. And you know I like them but how many first-year teachers envision that as their first assignment. (N/06/15/06 P.2)

In addition to his students' low level as well as the administrative pressure to prepare his students for the achievement test, Nathan also indicated that he taught out of his field. His content knowledge in Earth Science was not sufficient to teach Earth Science. Nathan explained "It had been ten years between the last meaningful earth science class I took and teaching earth science." (N/06/15/06 P.2)

Another crucial contradiction that he faced was time constraints. During his first year, along with his teaching responsibilities Nathan also carried out his graduate degree requiring him to invest considerable time in these courses. As he perceived that his graduate studies were more important than his teaching, Nathan often considered completely withdrawing from teaching and pursuing his PhD degree.

Nathan first-year activity system illustrates that Nathan's personal and professional identity interacted with his teaching context to significantly shape his first-year experiences. His personal identity as a self-sufficient individual restricted his openness to resources available for him at Kent High School. His identity molded his willingness to participate in various different levels of curricular and extracurricular community of practice within science department and across the entire school's activity system. Individuals who offered to provide him support received the message that if their help was needed, Nathan would ask for it.

As far as his first-year practices, Nathan's first-year activity system illustrated several critical changes in his activity system object. Except for his early student-centered teaching practices at the beginning of the school year, Nathan changed his practices toward a more teacher-centered manner. Citing the contextual constraints, Nathan came to understand that systemic change in science education as well as in Kent High School was not an achievable goal.

After his first-year experiences, rather than serving as an ideal for Nathan, "Science for all Americans" became a "fun little" phrase (N/02/03/06 P.14). He explained that as a teacher, he came to understand that in some cases "n-1 is greater than n." (N/02/03/06 P.15) By that he meant that for some of his students, school was not viewed as a privilege; rather public education was a right. Because of this perception, he realized that some of the students were "infringing upon the right of others to get the best quality education they can." (N/02/03/06 P.14) He noted,

If I can take the one kid that I yell at constantly in my first block, out of my first block, the science education that my first block would be better. Now I've got my thumb on him so he is not as big as a detriment. Two, the class, some of these other kids in my fourth block, but some of those kids in my fourth block have no interest in school. Are we doing them a...are we doing our other kids more of a disservice by allowing them to remain there? (N/02/03/06 P.14)

For Nathan, within his first-year activity system, n-1 could be truly greater than n. This was antithetical to the portrait of science education reform found in his preservice preparation, and Nathan surprised himself as he came to recognize that some students simply could not be taught science.

Nathan understood his student population to define how he could teach science during his first year. He understood that because of the traditional, teacher-centered science learning that his students were accustomed to, teaching science through inquiry was a disservice. Instead of gradually increasing the level of inquiry mindful of student abilities, Nathan chose to reject inquiry as a possibility in his school. Since Nathan understood the emerging contradictions as contextual and overwhelming, he had to transform his objects toward more survival meanings.

Nathan's perceived contradictions during his first-year teaching created significant emotional disputes. It was not a priority of Kent High School community to generate positive emotional energy for novices (Collins, 2004). A blend of Nathan's personal characteristics and the institutional structure of the school community, a vast amount of the contradictions in Nathan's first-year activity system became Nathan's own emotionally laden struggles, and they remained unquestioned.

Similar to the broad school context, Nathan also did not emphasize generating a positive emotional energy for his students to feel membership of a small learning community within his classroom context (Collins, 2004; Olitsky, 2006). Since he mainly relied on lecturing as a teaching style, he did not spend a considerable amount of time for planning and preparation. Because of his lack of preparation; Nathan was not able to use his classroom time effectively. Additionally, his teacher-centered teaching strategy did not require his students to actively participate in learning activities; his students were not able to feel that their contribution in science related activities were important. As a result of their lack of participation in science learning, students directed their interest in spending time among themselves, and that caused Nathan to have severe classroom management issues during his entire first year.

At the beginning of the school year, Nathan believed in a metaphor that teaching through reform was a battle against the traditional system. He wanted to make changes in his students' lives through his reform-based science instruction. Given the complex interplays within the system, Nathan realized that it was difficult for him to achieve his teaching goals and practice his idealism for "making a difference" at Kent High School. (N/06/15/06 P.2) In spite of his failure to achieve his idealism and his teaching goals, Nathan became more aware of the impact of context. He indicated that that he still had his idealism but "it is grounded in the reality of the system." (N/06/15/06 P.2)

According to CHAT, contradictions are significant aspects of an activity system because CHAT values them as bridges for individuals as well as entire activity system to develop and transform through a community of practice. Through his internalization of the entire Kent High School activity system, Nathan perceived that the contradictions that Kent High School context conveyed to beginning teachers were overwhelming. Through his externalization of these contradictions, Nathan changed his personal teaching goals

and his activity system object dramatically to adjust the school environment. His adjustment resulted in Nathan assuming a traditional teacher portrait that significantly contradicted his preservice student-centered idealism.

CHAPTER 6

A COMMUNITY MEMBER WITH IDEALISTIC GOALS: BOB

The purpose of this chapter is to provide a detailed examination of the *subject* in Bob's activity system; thus in this chapter, I will explore Bob's personal beliefs, his preservice pedagogical discontentment as well as his self-efficacy beliefs during the course of his first-year teaching and the way these constructs interacted to shape his enactment of science education reform during his first year as a classroom teacher. The following is a culmination of data describing Bob.

Just as Nathan seemed to be in the center of attention in almost any situation he was in, Bob could be found on its margins, and the edge of the "action," looking on. In undergraduate and graduate classes, Bob was the student who listened closely to discussions, nodding his head in agreement or disagreement or laughing quietly, only interjecting with his ideas when he felt they were absolutely necessary, and these interjections were often well constructed and humorous-- Bob didn't talk off "the top of his head." If called on, Bob would offer comments, but only after some thought and consideration. He often presented his position to the instructor and other students after class, when there was more of a chance for a true interchange rather than some sort of competition with an audience. Bob seldom appeared rushed even though he juggled the overcrowded life of most university students--exams, class projects, and working in local schools--and he approached tasks well prepared and deliberately, whether that task was preparing for a microteaching lesson or helping a faculty member organize the methods classroom. In courses he was often in the back of a work area, watching, quietly making suggestions to others or modifying their materials, then standing back and closely examining the results.

At the time of this study, Bob was a 24-year old white male with a quiet, understated personality. It was Bob's position that individuals should hold the utmost responsibility for their actions. As a means of enacting this position, Bob was typically calm and thoughtful, enabling him to become deeply engaged without allowing his emotions to heavily influence his actions. For example, Nathan and Bob happened to be in the same classes during their preservice education. Because of their personal and professional stances, there were occasions in which each held different perceptions over issues related to science teaching or broader issues of schooling. For Bob, these disagreements presented ways in which he could more fully understand another person's point of view and perhaps influence or learn from that point of view. For Nathan, these disagreements presented a win or lose case. Nathan would become heated in debates, in which Bob responded calmly, slowly, and thoughtfully, often slowing and lowering his speech and tone as the conversation became more heated.

Bob presented himself in quiet, understated, ways, but he was a "constant" in his undergraduate coursework. Sitting in the back of laboratory situations or student presentations, he would hold his questions until after much of the class discussion was completed. If he had advice or comments other than questions, these would often be offered after class, in one-on-one situations with the instructor or class member. He often was the person students would turn to for help, guidance, or advice. He was also an ardent sports fan who often marked "big game weeks" by wearing the appropriate T-shirt. In turn, he was a quiet political conservative in a largely liberal program--again offering his critique or take on different situations after a class session was ended.

Bob's Family Life and Early Childhood

Bob grew up on a military base in a poor rural region. In Bob's eyes, the context in which he spent his childhood provided with him a relatively privileged childhood compared to his counterparts. Both of his parents worked on the military base as civil servants, but they were not in the military. However, the entire community had a military culture to it, and that included his house as he was growing up.

Bob's parents were both college graduates. Before they started to work for the military, they had taught public school during late 70's. His father taught 8-9th grade

algebra for approximately 10 years. And his mother was a high school level Home Economics/Life Management Skills teacher for about the same amount of time.

Both of his parents read to him as a young child, and the thought of going to college was always talked about as a “given” within his family. Additionally, since both of his parents had master's degrees, they were open in their expectations that Bob would have at least the same level of education.

Bob contended that his out of school memories about learning science consisted of his parents taking Bob to zoos and the Space Center, as well as science museums-- which were often difficult tasks as such trips always required a good bit of travel given the position of his home town in rural Florida. His parents provided him with opportunities to see numerous places; however, he did not consider these activities part of formal learning of science. Bob explained: “I’d never really even thought about science until I got into the high school, to be honest with you. It wasn’t important.” (B/09/13/05 P.2)

We see hints of Bob’s early exposure to science-based activities in his later beliefs about learning, as Bob’s learning beliefs revolved heavily around a student’s enjoyment. This, too, appeared in his teaching goals as he contended that effective science learning had to provide enjoyment for students.

Bob’s early memories of learning science in school were few (i.e., growing plants in two-liter bottles.) For the most part, he did not consider such activities as actually science learning events, as these memories remained with him because of the nature of the activity (i.e., preparing the bottles for the plants) and not because of any conceptual content he retained. During his elementary and middle school years, Bob remembered mostly Life Sciences and Biology. For the most part in these early years, science was solely one part of the regular classes that he needed to learn. This situation shifted, however, when the topic was Physics, as this quickly became his favorite science subject, perhaps due to the influence of his father. He explained: “I remember when I was in middle school; I asked my dad what his favorite subject to the school was. He told me Physics. So from then on I was looking forward to physics class.” Indeed, when Bob “got into” his first physics class, he “fell in love with it.” (B/09/13/05 P.2)

Like most American high school students during the time of his schooling, Bob completed one year of Biology, and one year of Chemistry, but then he followed this with two years in Physics. Then, in his senior year, Bob also took an anatomy class. Bob asserted: “About half way through high school, science started to become my favorite subject, because the physics started really interesting me.” (B/09/13/05 P.2)

Bob contended that a majority of his teachers taught science using a traditional, textbook-oriented approach that emphasized the acquisition of factual knowledge. Although his Chemistry class had more lab activities compare to his other science classes, even here his teacher taught Chemistry through “college style teaching”. By college style teaching, Bob meant that his teacher, even in his class of ten students, opted to lecture. Similarly his Biology teacher also taught biology through bookwork and notes, and the class had only one lab activity (frog dissection). In retrospect, Bob described that neither his Biology nor Chemistry courses were particularly effective in terms of helping him understand these disciplines.

As opposed to many of his past science learning experiences, whose goals were mainly “memorization” and “finding the right answer,” Bob began to think of science as problem solving when he started taking Physics classes. (B/09/13/05 P.1) Bob believed that the nature of problem solving embedded in his physics class helped him to understand that learning science could be a practical matter rather than a set of abstract facts to be memorized. He stated: “I really... when was in physics class in high school, I really kind a buckled down more than in my other classes. I concentrated more, I tried harder.” (B/09/13/05 P.3)

Bob had two physics teachers, one of them with a fairly traditional approach, and another that who taught physics via laboratory facilitation. According to Bob, this second physics teacher had a “lighter personality (and acted) not like a teacher, but like a guide.” (B/09/13/05 P.3) As a role model, this teacher profoundly influenced Bob’s perception of teaching as well as teachers. Bob remembered that in one of the physics tests in this facilitator’s class, everyone in the class performed poorly. The following day, his teacher told his students that he was responsible for the poor test results because he did not teach the subject effectively. He then spent an entire week reviewing the subjects, followed by a second assessment. His teacher’s vocal acceptance of his role in the classroom was

crucial to Bob, and he understood this to be very motivating to the students, “Man, if students are gonna take a whole week just to redo this, if he is going to take the responsibility, then **I** need to take responsibility for myself, too!” Bob asserted: “So that is actually was the one of the things that made me start to thinking about being a teacher. So he had real influence on me.” (B/09/13/05 P.3)

Teacher Education and Preservice Experiences

During the first two years of his college life, Bob was a Sport Medicine major because of his enthusiasm for both science and football. During these years, Bob continued enjoying science, but he particularly enjoyed his 25 credit hours of physics. Then, one day, browsing one of the physics websites, he came across a notice asking: “Are you interested in becoming a physics teacher?” (B/09/13/05 P.4)

This question resonated with Bob, causing him to consolidate a lifetime of experiences--particularly his high school physics experiences-- and he came to realize that teaching Physics was what he wanted to do.

I knew that when I was in that physics class, I remembered all the fun that I had with it in high school. And I knew that if I could do that the rest of my life then I would enjoy my job. And then teaching just seems like a fun thing and it is always in the back of my mind so just kind a fit together at the right time.

(B/09/13/05 P.4)

Following up on this question, Bob met with Dr. Lamarck, one of the professors of science education, and the two of them openly discussed the possibilities, further fueling Bob’s interest.

As an extension of his personal history, Bob’s preservice teacher education experiences influenced his beliefs about what he understood to be effective science teaching. Because of his experience with overwhelming traditional teaching approaches, Bob initially believed that the primary role of the teacher was to deliver science knowledge. This fairly traditional conceptualization of science teaching was called into question during Bob’s teacher education program. During his 2 years of methods courses and his internship, Bob came to explore reform based philosophies and teaching methods. At first he was very critical of such methods, but as he developed he began to consider

more and more of these ideas and practices and make them his own. As will be discussed in this section, by the end of his preservice years, Bob believed that effective science teaching should be student-centered and activity-based, and he perceived that inquiry was the most effective way to achieve this goal.

Bob explained that the two years of methods courses and internship provided him with all the necessary skills and methods for effective, reform based science teaching. Bob indicated that all of his courses in the science education undergraduate program were designed to equip future science teachers with both prominent theoretical and practical aspects of science teaching. His professors taught the methods courses using various different approaches, and he stated “I would say mixed between demonstrations, group activities and discussions. There was very rarely lecture in my methods courses.” (B/09/13/05 P.5).

Bob described that Dr. Alan often emphasized the theoretical issues in science education and specifically addressed science education reform implications in her classes. Bob contended that he was one student, for whom such theoretical discussions coupled with practical applications, had some influence, and he described that Dr. Allan’s special emphasis on science education reform and inquiry really influenced his beliefs. Her classes and their associated field work caused him to question his traditional views of teaching and learning, and explore other more student-centered possibilities. As a role model for his teaching practices, Bob tried to base his teaching practices on Dr. Alan, explaining, “I always try to think what Dr. Alan would say about this lesson because I’ve seen where I can do some good.” (B/09/13/05 P.4) Another thing he learned from this reform emphasis was the need to provide effective science learning experiences for all of his students.

The heavy theoretical underpinnings in the program were contrasted with an equally strong emphasis on classroom management, and Dr. Lamarck’s focus on the practical aspects of field experiences. Indeed, Bob understood field experiences to be a viscerally important part of a preservice program because they provided opportunities to explore the interaction between theory and practice, explaining

[Field experiences] are invaluable, now that I am teaching between that and my internship I feel real prepared. I think the way the things were presented in terms

of teaching inquiry I think they did a pretty good job showing this why not just that one method but showing us pros and cons of different things. I think that [field experiences] were effective in showing how inquiry should look in a classroom. (B/09/13/05 P.4)

Bob specified that observing other teachers' practices provided him with opportunities to acknowledge what to expect in actual teaching context. These field experiences helped Bob to formulate his own way of teaching through observing other teachers to see what is effective and what is not. Bob asserted: "I just can't see how you could be prepared for it if you haven't had classroom experiences where, you know, you are [in charge]." (B/09/13/05 P.4) Clearly, Bob found the field component of his program essential in his development as a science teacher.

Bob spent an entire semester working in a middle school and another whole semester working in a high school for his internship. Bob entered the program intending to teach physics to high school students, based on his belief that high school students were more responsible learners and high school level physics involved upper level physics content that he personally enjoyed. It was during his semester long middle school field experience that Bob taught physical science once a week to a group of 8th grade resource students. Because he was "in charge" of this class once a week, in terms of planning, assessment, and classroom management, he recognized this experience as particularly challenging and useful.

Bob worked with two cooperating teachers, since his formal cooperating teacher was outside of Bob's content area. "In the mornings I taught one class where classroom management was the main thing I was learning. And then the afternoon, I taught in the other class where I learned more about [teaching via] inquiry than classroom management." (B/09/13/05 P.5) Besides shaping his teaching style, learning about classroom management was the most valuable aspect of his field experiences. Bob identified one of his cooperating teachers as a "hard core into classroom management, procedures and consequences." (B/09/13/05 P.5) He also learned classroom management skills from his cooperating teacher. Dr. Lamarck also focused on strengthening his classroom management during his field experiences by mentoring him, and organizing field experience discussion sections in which the preservice teachers discussed their field

experiences and learned from each other. It was evident that his varied field experiences each played significant roles in helping Bob shape his approach to the teaching of science.

Inquiry seemed to be the most influential aspects of Bob's preservice education. When he first encountered with inquiry, he perceived "it was a little hard to buy into it." (B/09/13/05 P.2) Via the program's explicit emphasis on inquiry and reform in science education, Bob changed his preconception about science education. In addition to his undergraduate program's emphasis, Bob indicated that his internship provided Bob with a perception that inquiry was not a solely theoretical ideal, rather, it could be practically applicable in science classes. Bob experienced first hand that inquiry-based learning experiences shifted the sole memorization emphasis of many science classes toward an active, enjoyable context where students were actively engaged in learning science. Watching his cooperating teacher employ such inquiry-based practiced was quite convincing for Bob, supporting the use of inquiry as well as supporting his prior belief that learning should be fun and engaging for students.

It was evident that Bob's preservice experiences played a considerable role in shaping his teaching goals and beliefs about effective science teaching. Bob indicated that inquiry was most satisfying construct that came from his teacher preparation program.

General Context of Lake Middle School

Based on his pre-internship and internship experiences, Bob expected a very challenging first year in teaching career in terms of knowing "what to do, when to do and why to do." (B11/17/05 P.2) —so he took great care in selecting the "right" place. After graduation Bob applied to several schools, mainly physics teacher positions. Although he did not want to take a teaching position as a physical science teacher at middle school level, he was well aware of the significance of starting the teaching profession in a school where he was comfortable. He stated:

I think it is also important if it all possible to be able to choose the school that you start because it is not isolated...the experience you have in the first job can really

shape how you teach. And the school where you're teaching is a very, very big part of the experience that you're gonna have. (B/06/22/06 P.10)

Therefore, for Bob the context of Lake Middle School seemed to be the best fit for him. And he explained:

Depending on your personality and your own experience you should choose the best school environment for your first-year experience. If you're grown in that environment then you will know how to handle special needs of that environment and then you will probably be successful in that environment. (B/06/22/06 P.10)

For Bob, Lake Middle School had a culture similar to Bob's own middle school, and he felt as though the school shared his values. So, when he was offered the position, he did not hesitate to start teaching at Lake Middle School. And soon into the first year, it became evident that the school environment fulfilled many of Bob's expectations and needs.

Lake Middle School was one of the eight 6-8 comprehensive public middle schools at the district with a middle level socio-economic status area in the Southeastern United State. It had a student enrollment for the 2005-06 school year of 331 sixth-grade students, 362 seventh-grade students, and 330 eighth-grade students. The racial distribution of the school population consisted of 70 % Caucasian, 25% black, and 3% Hispanic as well as 2% Asian. According to the state statistics, with 32% minority population, the student demographics of Lake Middle School represented the average minority student population for the district, with 19% of student population receiving free and reduced lunches.

The instructional staff consisted of 48 regular classroom teachers with a 1:21 teacher-student ratio. Lake Middle School promoted collaboration between teachers and parents as well as among the entire school body through the Lake Middle School Parent-Teacher-Student Organization (PTSO) and the Lake Middle School Advisory Council. Additionally, to supplement the sense of collaboration and also to promote teachers' professional development, Lake Middle School also supported grade level teaching teams as well as a Whole Faculty Study Reading group.

Similar to other schools in the district, all beginning teachers at Lake Middle School went through the District-wide First-year Teacher Support Program designed to

meet professional development needs of beginning teachers such as classroom management, ethics, abuse, reading across the content areas, and technology. Additionally, to support beginning teachers, Lake Middle School assigned a mentor teacher for all beginning teachers and encouraged experienced teachers to support these new teachers within their departments. Beginning teachers also had opportunities to work with retired teachers under the “Pop and Mom teacher” organization, one of the optional first-year support program offered by the District. The school administration allowed beginning teachers to have a student worker during their induction year to assist in grading.

In terms of student achievement, Lake Middle School received a grade of “A” for eight years in a row between 1998 and 2006 in state achievement test administration. Although this fact did not dominate the schools discussions, it certainly was a source of pride for many within the school. In the 2005-2006 school year, Lake Middle School received \$86,000 as a reward for their “A+” grade in the statewide standardized assessment system. The main elementary schools, which fed Lake Middle School, were also higher achieving schools based on their scores at the state achievement test.

In their vision statement, Lake Middle School stated that students should be aware that learning and self-discipline were primarily individual matters, and the attainment of these goals was a result of an individual's initiative. By promoting excellence through contemporary and challenging opportunities, as well as the curriculum, it was Lake Middle School’s goal to provide an education that allowed all students to become responsible, respectable of self and others, and to inspire them with a desire to learn over a lifetime. Within a system of accountability in which many schools struggle to respond the state’s achievement tests, Lake Middle School demonstrated a different school portrait in terms of priorities. The entire school community worked to carry out their vision to provide the most effective learning experiences for their students. Lake Middle School community provided a profound sense of support for Bob aiding his transformation to become a competent member of the school. Simply put, the school was a first-year teacher friendly school in which Bob experienced a successful first year.

Bob's Initial Beliefs and Teaching Goals

The literature illustrates that understanding teachers' beliefs about teaching and learning plays important role in attempting to understand teachers' practices (Smith, 2002). (Table 6-1 describes these early beliefs as well as their change over the school year.) This section focuses on Bob's beliefs about teaching and learning as he entered his induction experience. By describing his incoming beliefs, it will be possible to track visible changes in Bob's beliefs about teaching and learning as he moved through this induction year. Too, this preliminary description will help us recognize the interplay between his beliefs and teaching practices.

Table 6.1: Changes in Bob's science teaching beliefs and practices during his induction year.

	Preservice	During First Year	End of the Year
Beliefs about Teaching Science	-Reform/High Standards -Responsible -Favoring Accountability -Effective and enjoyable science teaching and learning	-Reform/High Standards -Responsible -Favoring Accountability -Effective and Enjoyable science teaching and learning	-Reform/High Standards -Responsible -Favoring Accountability -Effective and Enjoyable Science teaching and learning
Personal Self-Efficacy	High	Low	High
Outcome Expectancy	High	Moderate	Moderate
Pedagogical Discontentment	None	Limited	Profound

Table 6.1: Continued

	Preservice	During First Year	End of the Year
Classroom Management	N/A	Effective	Agenda for better Classroom Management
Assessment	N/A	Multiple -Traditional -Alternative assessment	Multiple -Traditional -Alternative assessment
Teaching Artifacts	N/A	Activities Classroom rules NOS skills Laboratory experiments Outside sources Textbook PowerPoint Overhead Projector Mind maps Bell-Work activities	Activities Classroom rules NOS skills Laboratory experiments Outside sources Textbook PowerPoint Overhead Projector Mind maps Bell-Work activities
Emotional Energy Generated	Profound	High	High
Overall Practice	Reform-Based Inquiry Enacting Science Education Reform	Activity-Based Student Centered State Standards and High Standards Didactic	Activity-Based Student Centered State Standards and High Standards Didactic
Object	Achieving High Standards Become a competent teacher	Achieving High Standards Effective and Enjoyable Science teaching and Learning	Achieving High Standards Effective and Enjoyable Science teaching and Learning
Teaching as a Profession	Second Choice	Considering to retire from this profession from this school	Teaching is a best fit profession

An investigation of Bob's initial beliefs about teaching science revealed that his beliefs were inseparably intertwined with his beliefs about what science is and how it works as a discipline, just has been describe by Tsai (2002). Bob's personal teaching philosophy, his view of himself as a learner, and his theories about how students learn science each influenced Bob's beliefs about what it means to teach science.

Bob's initial Beliefs about Science

Bob understood science to be a process, not a product. For Bob, “science isn’t after the answers and there isn’t necessarily a right and wrong answers [for scientific questions] all the time.” (B/09/13/05 P.6) Bob explained that in order for students to experience effective science learning, students needed to focus more on the process of science, using that process to take away explanations of an activity rather than solely trying to find an answer. Thus, Bob understood that his role was to help inspire his students to think about the process of how they pursue and acquire an answer for a scientific problem.

He explained that the whole idea behind science was “the communication of ideas and theories to promote a deeper understanding of how things work.” (B/ Teaching Philosophy P.1) In his point of view, in order to be a successful scientist, one had to communicate ideas effectively with others.

In terms of science as a subject, Bob believed that science was the most important subject as it integrated skills from other disciplines. Bob also stressed that “creativity” was a fundamental facet of science. For Bob creativity fostered in Language Arts promoted individuals’ understanding and exploration of natural phenomenon. Additionally, he perceived that history played a crucial role in science; thus, without reinventing wheel, scientists built their own ideas on the previous ideas of those before them. For Bob, scientific literacy figured into the utility of science through applying that knowledge in our out of school lives, thus he emphasized that science must be an integral part of every student’s education.

Bob’s beliefs about Nature of Science (NOS) became more explicit through understanding his beliefs about student learning since many of his beliefs about students’ science learning were related to NOS, which he envisioned to be very important for reform implementation. The following discussions about Bob’s preservice beliefs illustrate Bob’s understanding of NOS and approach to science education reform.

Bob's Preservice Beliefs about Reform in Science Education

As a preservice teacher Bob also supported the current educational system, based upon standards in which teachers and students were accountable for their performance in

classrooms, while he understood reform efforts such as National Science Education Standards (NRC, 1996, 2000) as focused on effective science learning for all students. For Bob, even the National Science Education Standards also propose a minimum set of knowledge for teachers to teach and students to learn science. However, he stated that it was impossible to standardize a general curriculum for the entire nation guided by one set of standards, because “some things are important to some people, and the same thing might not be important to someone else.” (B/11/10/05 P.2)

Bob was aware the difficulties related to achieving high standards within a system of accountability. He recognized the achievement of this goal as largely the responsibility of teachers. Bob often commented that “when you point your finger to someone you have three other fingers pointing you”. By this metaphor, Bob explained that many individuals understood education to be a matter of society and people (with teachers shouldering most of this burden). Indeed, Bob observed that in American Society, individuals often shifted what should be their own responsibility onto others. Bob specified “Maybe society in general has a little bit less importance on personal responsibility where some people just don’t feel like they’re responsible for what they do.” (B/09/13/05 P.3) Bob believed that teachers were the most important members in the society and their primary responsibility was not to focus on obstacles that prevent them from achieving their goals. Rather, he stressed that teachers need to take responsibility to perform at their best level to teach effectively.

Bob’s perspectives about achieving both state level and high standards illustrate his recognition of the practical and theoretical contradictions within the system of accountability. Bob was aware of the tensions between accountability and teaching science for all, and he was aware that teaching to high standards was fraught with difficulty.

Specifically, Bob noted that current accountability measures via statewide standardized testing were one of the most crucial aspects of the current educational system and he understood it to influence all facets of teaching and learning. For him, the goal of the current state achievement testing was to assess whether the students learned about the state science standards to a sufficient degree, but he understood this to be complex, “I think we are trying to do that with the [state achievement test] to make sure

we have the standards but I am not sure if we're testing high standards." (B/09/20/05 P.2) For Bob the state achievement test results might not be able to assess high standards originated by the national reform movements (AAAS, 1989, 1993, 2007; NRC, 1996, 2000), as there was such a heavy emphasis on student problem solving and process skills that were not being tested on a state level.

Before starting the teaching profession, Bob embraced the state standards for content:

I am a firm believer in setting high standards. If you are satisfied with mediocrity, then you will surely never surpass it. However, if you always set your goals high, then the mere efforts you put into obtaining them will boost you past mediocrity and into excellence. (B/Teaching Philosophy, P.1)

Bob envisioned himself basing his curricula around the state standards and taking responsibility for teaching his students appropriate content in effective ways. Bob understood his strong conviction in standard-based education also made him "a fan of [the state achievement test]" as a tool to assess whether or not those standards were being met and as a tool to motivate students within the school system.

It was clear at the outset of his first year; Bob was torn between the emphasis of state's accountability system and the national reform efforts. He hoped that science teachers' steady attempts to provide effective learning experiences for their students would help students to achieve both state level and higher standards described in the reforms. That's the way he saw himself teaching--teaching for students' deeper understanding of concepts, and understanding what would also allow them to succeed on state testing.

Although for Bob to achieve high standards specified in science education reform was a difficult task for a teacher, he believed that all students were capable of achieving high standards and learning science. Too, he was aware of the fact that some students might not necessarily have the "willingness" and "motivation" to achieve well since these students did not have the motivation and solely "think for today but not for tomorrow". (B/09/20/05 P.1) In order to motivate these students to learn science, Bob thought small-group activities would play a central role in helping his students enjoy learning science.

Bob understood that collaboration among his students was another significant aid in motivating students who held relatively low motivation to learn science.

Aside from lackluster teaching, for Bob, the most crucial reason for some students' disinclination for school originated in their family lives. He recognized that some students did not have parents that valued education. Thus, he envisioned that to be effective with all his students, he may need to work to enlist the aid of parents.

Bob's Beliefs about Science Teaching

As his first year of teaching began, Bob saw teaching as a "noble profession" and he took pride in being a teacher. (B/09/13/05 P.6) As he began the year, he wanted to teach until he retired, teaching was his professional home.

Before he started his first year, the central aspect of Bob's teaching philosophy was to foster students' higher order thinking skills in science classes. Bob indicated that most of his previous learning experiences were shaped in classroom contexts where the main method for teaching and learning applied was "a lecture/laboratory confirmation format." (B/ Teaching Philosophy, P.2) After his preservice education, Bob recognized that this traditional format was not the most effective way to cultivate students' higher order thinking skills. He believed that within the traditional learning environment in which the main learning formats were lecture-based instructions, cookbook lab activities, students were not "challenged to push their own thinking and understanding forward." (B/Teaching Philosophy, P.2)

Bob believed that an effective science teaching had to inspire students to think about their own learning and engage them to understand what they learned from an activity, not to confirm what was in the book or what their teachers taught. By engaging his students with metacognitive activities, Bob envisioned his teaching as inspiring his students to "really sit down and think" about their own learning (B/09/13/05 P.5) Consequently, for his first year in teaching, Bob noted "I wanna' keep it like that, where every week we're doing something that makes some kind reevaluation of where they are." (B/09/13/05 P.5)

To achieve his teaching goals, Bob confirmed that his preservice education provided him with the necessary theoretical and practical facets of effective, reform-

mind science teaching. His preservice learning emphasized the promotion of students' higher order thinking skills through inquiry-based science teaching. According to Bob, teaching through inquiry was the most effective teaching method to make teaching and learning experiences effective in science classrooms. While he learned what inquiry was on a theoretical level in methods classes, during his student teaching period, he was able to learn the effectiveness of inquiry-based science teaching on a practical, real-world level.

Bob also held other components of reform-minded pedagogy as central to his own teaching. For Bob, intensive relevance of classroom learning to student's own lives is essential in enhancing students' effective learning experiences. Bob explained that there were few fields other than science that provide a teacher with better opportunities to show students how and what they are learning is important.

The physical laws they learn are the same ones that govern their every day lives. The chemical properties they learn are the same ones that are so vital in the makeup of their own bodies and in the universe they live in. The biological phenomena they learn are the same they can observe in themselves and in the life that is all around. (B/Teaching Philosophy, P.3)

Too, for Bob it was also important to foster an interest in presenting students the ways in which science and technology interact with each other than in today's world when knowledge and applications of technology are growing exponentially.

Bob also highlighted the importance of effective classroom management as an important contextual factor in science teaching. Bob observed that in his cooperating teacher's classroom a "smooth running" classroom promoted learning. Bob explained: "the best way to accomplish this is through procedures and reinforcements for those procedures." Bob believed that students' learning would be enhanced when students knew what was expected of them and when it was expected. (B/09/13/05 P.5) It was clear that Bob believed in the significance of creating a learning environment where students are responsible for their actions and behaviors.

Bob expressed that students' recognition of the need for responsibility is an issue that gains importance as one leaves the school grounds. Bob saw recognition of

responsibility as a “life lesson” that can be appropriately learned in school where the stakes are relatively low:

Part of being a teacher is to help shape students into productive citizens. I believe it is part of my responsibility to set my standards high, with positive expectations, and do everything within my power to help my students achieve them.

(B/Teaching Philosophy, P.2)

Based on his overemphasis on high behavioral standards, Bob stated that it was his goal to create a well-managed classroom where students’ learning would be effective. By referring back to Harry Wong, a prominent figure in his classroom management course, Bob argued that “a well-managed classroom is a task-oriented and predictable environment.” (B/ Teaching Philosophy, P.2) Thus, he specified that the best way to achieve this is to have a standard set of classroom procedures, which should help students concentrate on their learning by knowing what is expected. Within a predictable and productive learning environment and under the guidance of high achievement and behavioral standards, Bob concluded that it would be his responsibility as a teacher to support his students in the development of the tools necessary for success in school and in the society.

Bob’s Beliefs about Student Learning

Bob’s beliefs about teaching resonated with his beliefs about student learning. The strong influence of Bob’s reform based preservice education was also evident on his beliefs about student learning. Along with the role of a science teacher as a facilitator in implementing science education reform, Bob understood that in an effective science learning environment, teachers must emphasize their high expectations if they are to motivate students to learn science. Bob explained that if we were to act on his teaching philosophy, his biggest strength would be his high expectations for his students. He envisioned himself becoming a teacher “who sets the bar high for his students and does his best to facilitate their success in reaching those goals.” (B/ Teaching Philosophy, P.3) He observed:

I think students pick up on their teacher’s expectations of them and respond accordingly. If you expect good work from your students, you are more likely to

receive it. If you expect sub-par work, your students are more likely to underachieve. (B/ Teaching Philosophy, P.1)

As discussed earlier, he also explained that his 11th grade physics teacher's once identified himself as the biggest reason for his students' underachievement in a test. Bob indicated that this was his most prominent memory from his school years and deeply influenced his growing teacher identity. This memory is very important to Bob, as he recognized that this teacher's goal was not to assign certain numbers for his students' performance or to cover all the materials in the book. Instead, his teacher's goal (and one that Bob took as his own) was to facilitate "actual learning" where his students would internalize and achieve their own learning (B/ Teaching Philosophy, P.3). Thus, he contended: "...if I can get one kid a year, or one kid a class even to be inspired about the stuff, then I've affected somebody." (B/09/13/05 P.5)

Bob also highlighted several pedagogical issues about students' science learning, one of which concerned scientific rules and facts. Bob explained in a traditional learning environment, presentation of scientific rules and facts gave students an impression that science was a set of procedure to be memorized. Rather, "within a set of classroom rules" Bob perceived himself to be encouraging his students "to come up with their own procedures" during his first year in teaching (B/09/20/05 P.5) Although formulas and procedures were the necessary facets of sciences, Bob did not place any weight on having his students' memorize such information. Rather, he planned to center his teaching to focus on his students' skills using this information. Clearly, Bob had a process orientation to science and to the learning of it as he began teaching at Lake Middle School.

Bob also believed in using a learning environment that supported his students in "thinking creatively" to learn the scientific inquiry (B/09/20/05P.6) For Bob, constantly guiding students in a sequential manner through the scientific process would restrict students' thinking process and their creativity in learning science. Allowing his students' to come up with their solutions by using scientific inquiry skills seemed to be another important aspect of practice as Bob entered his first year at Lake Middle School.

For a better understanding of Bob's beliefs about student learning, it is also promising to explore Bob's perception of NOS as an essential facet of reform-based science teaching. During his preservice years, Bob acknowledged that a student-centered

teaching approach required Bob to provide his students with the necessary foundational understanding of NOS. Through NOS activities Bob planned to pay particular attention to intensification of his students' scientific inquiry skills to communicate their ideas "scientifically, academically" among them. (B/09/20/05 P.6). Along with the communication skills, it was Bob's goal to expose his students to the idea that science was not magic where one "plugs in numbers in a formula and gets a result." Instead, he wanted his students to understand that getting the right answer was not a sole indication of his students' understanding of the subject. Indeed, in his perception of successful implication of science reform, teachers should equip students with skills to explain and communicate the process of science and support their ideas with scientific evidence.

Bob's Preservice Self-Efficacy

Bob was very enthusiastic about getting started in his first-year of teaching. An investigation on his preservice self-efficacy beliefs revealed that Bob started the teaching profession with a high self-efficacy, recognizing himself as someone who would be able to teach science effectively for all students. Bob envisioned his success to be due to his continuous effort to evaluate his effectiveness of teaching science and search for alternative instructional practices to provide his students with a robust and effective physical science learning experiences.

Bob recognized that he had a profound grasp of science concepts so as to teach them effectively. He did not envision any difficulty in teaching middle school physical science content to his students. Bob saw himself as acting as a competent teacher who was able to help students when they had difficult questions or a difficulty in understanding physical science. Instead of perceiving students' questions as a challenge, Bob anticipated that he would welcome his students' questions and consider these questions as a crucial part of his first-year teaching context.

Based on his preservice teaching experiences, Bob described himself as an effective science teacher who knew the necessary steps to teach physical science content effectively. Although he was not quite sure about his effectiveness on monitoring his students' learning process, Bob saw himself as a competent teacher who would seek out opportunities to improve his teaching knowledge and skills. Bob specified that students'

disinterest in his classes may be the major indicator if something is ineffective in his class. Bob explained:

...you can see it on their face, if they just kind of pushed their work off the side. There is not that enthusiasm to do it. Then, if they're not motivated to do the work, then they're not gonna do the work. If they don't do the work, and they're not gonna learn from it. So I think if you start to see that disinterest, then you know you kind a going to wrong direction a little bit. (B/09/13/05 P.3)

By using his students' interest as an indicator, Bob would work to find techniques to increase his effectiveness. Bob believed that if something was ineffective in his class he believed that he had the biggest responsibility to address the problem. Bob expressed: "I think I have more control over what I do than I do over what they do." (B/09/13/05 P.3)

At the outset of the school year, Bob explicitly described that a teacher's effectiveness as one of the most crucial determining factors in students' effective learning experiences in science classes. For Bob, when the science grades of students improve, it was most often due to their teacher's effective teaching. Similarly, Bob believed that if students were underachieving in science it was most likely due to ineffective science teaching. So, because he conceived himself as a highly effective teacher, and given this relationship between a teachers' ability and student outcomes, he had a very high outcome expectancy for science teaching--for all students, even those with inadequate background knowledge or poor motivation. (Although he was cautious about the other determining factors influencing students' science learning. He envisioned that science teachers might not be the only responsible group to blame for students' low achievement in science.)

Bob's Initial Pedagogical Discontentment

Based on his teaching experiences during his methods courses and during his internship, Bob saw himself as having the necessary skills and theoretical underpinnings to enact reform-minded pedagogy. Bob envisioned himself facilitating inquiry-based teaching within physical science content. He anticipate that NOS would be a prominent part of his first year preparing his students to assume new roles such as being responsible of their learning, communicating their ideas, progressing to become creative thinkers, and

realizing the global perception of science in his first-year teaching context. Overall, he saw himself as prepared for this challenge and thus, had scant pedagogical discontentment as he entered his first year.

That said, Bob's pragmatist identity became evident. Based on his preservice experiences, Bob perceived that students with low motivation and low expectations would challenge his teaching abilities. Bob envisioned himself heavily relying on convey collaboration among students as well as activities to address this difficulties.

Bob's beliefs about students' learning suggested that it was one of his goals to connect physical science contents with his students' lives. He saw himself has experiencing some difficulties in balancing his personal teaching goals with those of state standards and national science standards as well as his students' needs.

As far as Bob's foundation about his content knowledge, during his college years Bob prepared himself to teach high school level physics. Bob believed that he had the sufficient physical science content knowledge to facilitate effective learning experiences for his students during his first year at Lake Middle School, thus he had no pedagogical discontentment in terms of his content knowledge as he entered his first year.

In terms of his pedagogical knowledge and perceptions related to assessment before he started to his first-year teaching, Bob believed his assessment techniques should assess his students' higher order thinking skills so that he would be able to assess his students' "analysis skills and their synthesis skills" which he believed to be the necessary components of students' accurate understanding of physical science subjects. (B/09/13/05 P.3) as well as informing his curriculum planning. As a beginning science teacher, his lack of experience prevented Bob from specifying the assessment techniques that he would use. Indeed, it was evident that Bob would rely on spontaneous student reactions as an assessment technique. He explained that he learned in his preservice experience that "It is like a light bulb goes off in their face... their eyes are open up, and you can see the connection happening between what I am trying to teach and what they've learned before and through their past experiences." (B/09/13/05 P.2) Thus, while he was at a loss to describe all the assessment techniques that would allow him to meet his teaching goals, and he recognized this paucity of techniques that he was familiar with,

he didn't experience a great deal of pedagogical discontentment in term of this facet of his teaching.

Overall, Bob was relatively contented with his preservice practices, with the notable exception of formal lesson planning. Bob stated that as a part of preservice requirement he had to prepare lesson plans with a certain formal format defined by his professors. However, Bob explained:

I think it is impractical to sit down and type a formal lesson plan for everything for everyday. I think the more practice you get the better you get at shooting from the head like improvising a little bit I guess or just keeping it on all your head and knowing "Ok. I wanna teach this and I have to do that. (B/09/13/05 P.1)

Bob believed that because of their "impractical" aspects, formal lesson plans that he knew how to prepare would not aid him in the way he envisioned himself teaching science. (B/09/13/05 P.1) Additionally, Bob argued that being aware of the certain need of students held enormous amount of impact on how teachers need to teach. During his preservice years, he expressed that he did not have an opportunity to know his students' needs. Therefore, it was impractical for him to have a lesson plan without the knowledge of appropriateness of his lesson plans to fulfill his students' needs. Thus, of all the area of possible discontentment, lesson planning posed the greatest discontentment for Bob.

Changes in Bob's Beliefs during his Induction Year

The purpose of this section is to outline Bob's beliefs about teaching and learning science that he held in the midst of his first-year teaching to better understand how these beliefs changed from the pre-teaching period. Although there were not salient changes observed in his beliefs during this period, I documented a significant interaction between his beliefs and practices mindful to reform implementations during his first year. Through focusing on specific beliefs related to science teaching, we will explore how Bob's preservice beliefs explicitly shaped his first-year teaching practices.

Changes in Bob's Beliefs about Science

Bob's first-year beliefs about science were similar to the ones that he held before starting to teaching profession. Bob believed "Science is questioning, trying to ask the right questions and trying to find the right answers for these questions, I guess about the

world, the universe.” (B/04/03/06 P.1) Relevantly, he described “If science is asking questions then it kinda has to start with asking questions. Why do we see this, what could be going on? So, I would think questions would play big part how you teach science.” (B/04/03/06 P.1) According to Bob, since the challenging nature of this approach required teachers to hold a comfort level to carry on their lessons through students’ own inquiry process, many teachers were not comfortable facilitating this approach.

As far as Bob’s specific belief about NOS, before he started his first year teaching at Lake Middle School, NOS was a prominent part of his teaching goals and during his preservice years. He spent first six weeks of the school year for NOS activities, and through these activities he tried to help his students develop the essential NOS skills and knowledge of NOS. Bob’s early emphasis on NOS activities helped his students realize new sets of roles as active learners as well as to develop essential skills required for his largely inquiry-based classroom context. Bob worked to equip his students with specific foundational skills and six essential activities with the process of science: observing, measuring, inferring, predicting, classifying, and communicating. One of the examples of such NOS rich, process-heavy activities was “Product Research for Bubble Gum.”

The question for the activity was “Have you ever been frustrated that your bubble gum seems to lose its flavor too quickly or that the bubbles just don’t get big enough? Students were then directed to:

Imagine the 8th grade at Lake Middle wants to adopt an official class bubble gum. Your task is to perform some product research to determine the best brand. So, design an experiment to find out which of the 3 leading brands of bubble gum keep their flavor the longest *and* which brands blow the biggest bubbles. Explain your methods and give examples of some ways that you could communicate your results to the 8th grade student body. (B/Lesson Plan)

For the activity, Bob wanted his students to pay attention to science process skills as well as addressing the following questions during the activity.

How will you keep your experiment unbiased? Which variables will change?
Does anything need to remain constant? What kinds of standards will you set?
(B/Lesson Plan)

Bob also wanted his students to specify their independent (Test) variable, dependent (Measured) variable, and controlled variable.

Another NOS rich activity echoed one completed by Nathan. Through addressing his students' preexisting perceptions about science and scientists, Bob wanted to address his students' understanding of scientists as a stereotype, commonly seen in our society. The objective for the activity was to discuss the misconceptions that the society held about science and scientists. For the activity, Bob provided students with paper, colored pencils and markers. For the activity, Bob asked his students to close their eyes and told them to imagine in their heads a scientist. After that he wanted his students to imagine what their scientists were wearing, what their scientist looked like, and if there was anything in the scientist's environment. After a brief pause, Bob had his students to open their eyes and began drawing their vision. After an appropriate time for them to complete their drawings Bob had his students to turn them in. By using his students' drawings he then made a list on the board of the following: gender, race, lab coat, big hair or hair on fire, glasses and/or goggles, working inside a lab/holding a beaker or glassware item, chemist or any other scientist. After this detailed list, Bob facilitated a survey to find out how many of his students drew their scientists with any of these qualities. At this point the class realized that majority of the students drew a white male working at a laboratory. After the survey results, Bob facilitated a discussion with his students why they drew certain traits on their scientist and then he led them to discuss if these were stereotypes or misconceptions. During this time, Bob used several ideas to facilitate a series of effective discussions for the activity. After this discussion Bob posted his students drawings in his classroom. Some of the ideas were:

- How does the media portray scientists?
- Who would like to see DiDi have the laboratory in "Dexter's Laboratory?"
- Was Jane Goodall a scientist?
- What's the deal with the scientists in "Flubber," "Cats and Dogs," and other popular movies?
- Why aren't there more female scientists written about in history? What did Madam Curie have to endure as a female scientist in the 1800's?
- Why are scientists portrayed as "mad?" (B/Lesson Plan)

The source of his early emphasis on NOS was his preservice education program, which explicitly focused on reform-based science education. Through the lens of reform implications in his preservice years, Bob was able to rethink his own early learning experiences as a student during the elementary, middle school and high school. Many of his science classes lacked opportunities for students to discuss their ideas. In his classroom, he consistently worked to encourage his students to discuss and communicate ideas in his classes.

Changes Bob's Beliefs about Science Education Reform

Bob's implementation of activity-based science teaching explicitly resembled the outlines of reform efforts in science education. Bob observed that inquiry-based science teaching was not yet "an everyday thing" for many teachers; however, Bob mused "I think most science teachers are trying to head toward inquiry." (B/04/03/06 P.2) In terms of the specific Lake Middle School context, inquiry and reform were not wild ideas for science teachers and many of the teachers at Lake attempted to orient their classes toward more inquiry-based teaching by molding their science teachings in "hands-on" and "question-oriented" nature. (B/04/03/06 P.2) It seemed to be a common idea among the Lake Middle School science teachers to challenge their students toward seeking answers for their questions through the process of science rather than giving them the answers. Lake Middle School science teachers' understanding of the reform and their practices in reform implementations empowered Bob and enhanced his self-efficacy to apply what he learned during his preservice education.

The existing culture of Lake Middle School also helped Bob to recognize the influence of his preservice education on his first-year practices. In terms of his preparation toward implementing science education reforms and becoming a competent science teacher, Bob appreciated the influence of his preservice program to improve his previous perceptions about teaching and learning, which he structured before his college years. Bob explained:

When I got into the program I hadn't thought about you know doing a lab without really knowing the concept first. Like discovery labs, I have never imagined that because every day what I did in my school was you learned it, you had the

cookbook sheet in front of you follow the steps and magic happened you know. So, without the science education program at [the university] I wouldn't have done any of that. I would have been giving notes on the overhead and take a test. (B/04/03/06 P.2)

Bob also came to understand that in order for teachers to implement reform efforts in a teaching context, teachers needed to see the reforms "pulled off" in classrooms. Too, he became aware that in order to change toward more inquiry-based classrooms, teachers need to be dissatisfied with what they do in their teaching context.

Surprisingly, Bob came to understand that context was not the central factor influencing the enactment of reform recommendations. Bob stated that if teachers realized the benefits to teach through inquiry, there were many options and alternatives to design experiments, activities and labs even with limited supplies.

I think it takes more time to rethink your curriculum if you try new stuff you got to try it out and test it, you know, organize it. Well, as far as the equipment goes, there are so many ideas and activities out there from the teachers that come up with that they don't require a lot, you can go to Wal-Mart and pick up what you need. So, if you're desperate you can find cheap labs to do. I don't know that the money is directly correlated to it. I mean if I wanted to bad enough I could have come up with some kind of force and momentum activity that my kids could do with their math and that I could have the equipment for it. If I wanted to bad enough I could have. (B/04/03/06 P.4)

Consequently, Bob understood that it is a teacher's own motivation to teach through inquiry that was the leading factor influencing the fate of reform implications in science classes.

Bob also realized that there were several other factors that played significant role in supplementing reform attempts in science teaching, ones secondary to a teachers' motivation to change. One of the requirements that he perceived was curriculum, which he understood must be aligned with the standards for reform. Bob recognized the state's science standards were strong determining factors shaping science instruction. Indeed, Bob believed that it was his primary responsibility to teach to the state science standards,

although to allow adequate time on important content, Bob selected to teach the minimum content specified by the state standards.

Bob also believed that textbooks and other instructional materials had to be aligned with the curriculum if science teaching was to be successful. He pointed “[aligned materials] are important for me, and I don’t have to do the extra work to figure out what goes with what.” (B/11/10/05 P.3) Therefore, Bob contended that teaching support materials should help to reduce teachers’ ambiguity.

Bob was not a strong admirer of technology, although he understood that the appropriate use of technology might support science teaching. Indeed, technology did not seem to be important part of his classroom teaching. Rather, his use of technology was limited to PowerPoint and/or overhead projector if their use was necessary to supplement his discussions and activities.

Changes in Bob’s Beliefs about Science Teaching

Among many other essentials factors for successful reform implementations in science education, for Bob, a teacher’s own effort and enthusiasm were the most significant requirements for effective science teaching. Thus, for Bob it was teachers’ responsibility to help students understand the content. He believed that teachers needed to have passion to enhance students’ understandings, teachers needed to be persistent in finding the most effective approaches to teach. In order to keep their enthusiasm alive Bob explained that teachers needed to like teaching and enjoy being in classroom. He stated “If you don’t like the students, I don’t see how you could like this job.” (B/11/10/05 P.5)

Bob also emphasized the importance of teachers’ role to create and maintain a learning environment where teaching and learning were the main concern. For his first-year teaching, Bob placed a great deal of time and attention on classroom management to ensure that his classroom a safely and students acknowledged the procedures and rules. For Bob, effective classroom management was required for student learning. Bob stated “...there needs to be structure and the way we do things....” (B/11/10/05 P.5) Consequently, he described that an effective learning environment was orderly since students could not learn in a classroom with “chaos.” (B/11/10/05 P.5)

Bob largely employed a student-centered and activity-based teaching style in his first year at Lake Middle School. For Bob the most effective way to teach science was to place students' questions at the center of science classes and facilitate a learning environment where students attempted to find answers to their questions. Inquiry was central to his teaching. As discussed earlier, his perceptions about Nature of Science molded and shaped most of his practices toward student-centered and activity-based practices during the first period of his teaching. As far as the success of his first term teaching, Bob seemed to achieve all of his teaching goals in terms of creating an active learning context in his classroom.

Also echoing his preservice beliefs, for Bob the state's science education standards represented the minimum amount of science that students need to know. The most effective way to teach these standards for all students was to teach science through inquiry. Looking at Bob's first-year teaching practices, it became evident that the standards and the reform implementations could be quite compatible, if a teacher had an adequate understanding of standards and the reform. Essentially, during his first-year teaching, standards were the practical goals Bob focused on for all of his students, and the reform specified the best way to orchestrate this learning.

It is important to note that Bob's mid-year teaching practices slightly differed from those that he used for his early NOS units. As he reflected on his teaching at mid-year, he recognized that his teaching had become more didactic. Bob indicated "I think I'm probably a little bit more teacher-based than I thought I would be as far as putting the PowerPoint up, we haven't been doing quite as many labs." (B/04/03/06 P.3) According to Bob, there were several reasons for him to fluctuate from activity-based student-centered teaching toward more teacher-centered teaching. One of them was the content that he was currently teaching and the limited sources with which he could facilitate activities and labs for the current content. For instance, during the course of his midterm teaching, Bob taught momentum and force units and he employed only one lab for these units. He indicated that if he were to have more equipment (like the equipment he had access to as an intern), he could employ more useful activities, enhancing students' understanding of force and momentum dramatically.

Another contextual obstacle pushing Bob to become more didactic in his teaching was the constant lack of time. At the beginning of the school year, Bob and his planning partner (another 8th grade science teacher, Rose) spent significant amount of time on Nature of Science, and this contributed to his midterm time constraint. Going back to the time constraint that influenced Bob's midterm teaching practices, during the second semester Bob and Rose volunteered to participate in a research study in which they devoted a week of their class time for the research. In addition, the pressure of upcoming the state's achievement test for which required Bob to speed up his teaching to "cover" the required standards before his students took the test was another contextual reason for Bob move toward more didactic teaching.

Additionally, as a beginning teacher, there were also some internal facets, which seemed to be preventing Bob from achieving his teaching goals during his midterm teaching at Lake Middle School. To prepare effective student-centered learning experiences for his students, Bob needed to engage in searching for and designing activities, which required a considerable amount of time. Given the demands of the first year, Bob sometimes felt tired and lost his motivation to spend extra time for preparation for student-centered experiences. He described his lessening of motivation and unwillingness to devote extra time this as one of this internal limitations to implement his teaching goals.

As far as the external constraints that prevented him from implementing his teaching goals, Bob understood that occasionally his students' level of math did not allow him to teach science effectively. Bob stated:

I mean if they hadn't had the math, I can't teach them the math. It would be unfair of me to try bringing the higher level math for these kids. Because I mean like you saw the unit they're not just ready for it yet. They don't have the background. I know I a lot of that is my own frustration because I enjoy the higher level math. Yeah I'm a very numbers-oriented person. If I can see the numbers on something then generally I can make sense of it. Whereas, some people have to like actually see it happening or some people have to read about it happening...so maybe different learning types. (B/04/03/06 P.7)

It was evident that Bob sometimes taught science as if his students were high school level students. Bob expressed: “It frustrates me when I can’t talk about the cool way to solve a problem because they don’t have you know, they don’t have the math.” (B/04/03/06 P.7) For example during one of his classes, while he was working on a problem, he started making assumptions for a further application of the question by converting question into a very complex shape, which required students to have modest amount of college algebra and trigonometry skills. He solved the problem by himself and when he tuned back to his class to see what his students think, he saw that the entire class was lost. This sort of experienced frustrated Bob, and he recognized that he was not able to teach in ways that seemed straightforward to him because of the lack of mathematical knowledge of his students.

Changes in Bob’s Beliefs about Student Learning

Although there were times that he wanted to use sequential directions in his teaching to “help [his students] to organize things,” Bob usually aimed to facilitate lessons that required students to think creatively and systematically to complete an activity. (B/11/10/05 P.6) According to Bob, it was critical for science teachers to underscore the significance of designing and using procedures since a rote use of a set of procedural guides in science teaching could hinder students’ own attempts to think creatively and make sense in science classrooms. Instead of giving them certain procedures, Bob wanted to promote his students’ “active participation” in classes and “their own attempts” to find the best answers for the questions. (B/11/10/05 P.5) As far as student learning Bob explained:

...the learning actually comes from “Ok we’ll try it out, and see what happens.”

And to try it one way if it doesn’t work and try a different way and it doesn’t work, and then they try the third way it works. And then, you say “Ok, why did it work the third way and why not the first and second way?” (B/11/10/05 P.5)

Additionally, directly reflecting his beginning beliefs, at the mid-year, Bob continued to be a teacher who accepted the ultimate responsibility for students’ underachievement and ineffective learning experiences. Bob continued to believe that all

students were capable of learning science, and he was also capable of teaching science for all students.

To this point, the description has suggested a “rosy” portrait of Bob’s teaching and demeanor. And overall, he was effective. However, it was evident that his effectiveness and practices varied in each of his classes. Bob’s attitudes and teaching approaches fluctuated among his classes because of particular students’ influence on the culture of the entire class. Indeed, in each of his classes, there were a few students with disruptive behaviors, and whom drew Bob’s ire. These students were able to change the entire climate of a classroom. Bob noted: “not doing assignment and getting zero is not a big deal [for those students].” (B/02/27/06/ P. 3) He understood these behaviors as largely a motivational problem that originated from the students’ family lives. These students seemed not only to be completely uninterested in not only learning science but disengaged with the entire the idea of schooling.

The negative influence of such students in his classroom environment became easily apparent when the school administration moved some of these students from his class to reduce his classroom size by the midterm of the school year. After the change, Bob’s teaching context became more productive. Rather than dealing with management issues, Bob and his students were able to focus on teaching and learning. He also mentioned,

I’ve got one that distracts them and you know that he’s somehow a leader and they follow his lead then that makes it a bad class. And I had one of these. Now he has gone and that is a great class, they’ll work for me, they’ll do what it takes just by removing that one influence. So I’ve talked about him too like if you remove one kid from my class it is amazing to see how it affects my class’ performance. Yeah, I completely agree with that. I had one kid who made it so hard on me everyday. I focused all my attention on him just you know behavior wise. I wasn’t even able to think about science; it was all keeping the kid on track because when he got off track the entire class followed him. Well that kid got into trouble and is not in school anymore. And now that class is interested in learning. When I bring something up they’ll talk to me about it whereas before it was all about that kid. So, n-1 is in that case infinitely better than n. (B/02/27/06/ Pp. 8-9)

During some particular periods of his midterm teaching, Bob was relatively strict compared to his first term. His attitudes toward particular students sometimes significantly affected Bob's teaching. In few occasions when the classroom management was a significant problem, Bob changed his way of teaching to penalize the entire classroom, abandoning the activities for that class for a full week. During the week of crisis, Bob assigned his students bookwork, and he taught through sole lecture style during that week. It was evident that this practical solution to handle management issues helped some of his classes so that students began "policing" themselves. When one student showed inappropriate attitudes, other students warned their friend to prevent another week of being away from the activities since activities were the most compelling part of Bob's teaching context for his students.

As far as the effectiveness of his activity-based teaching style on his students' science learning, most of his students seemed to benefit from Bob's teaching. These students held higher expectations and their excitement upon entering his classroom each day was obvious to an observer. The students entered excited to see what was going to "happen" that day. He explained:

...that's a good thing. I mean you want them excited some. Ok, maybe we get to do lab today and then when we had the lab set up, they're ready to go, I mean they're excited about it. I think if they're that interested, I think we've done something right. So, I would call it as success. (B/02/27/06/ P. 3)

The success in motivating his students toward learning science seemed to be the result of Bob's higher expectations from his students. Before he started his first year, it was one of his goals to set high expectations from each of his students. Once Bob set the bar very high, and he facilitated many activities, students came to his class with high motivation in response. This expectation created a pressure on Bob (and his planning partner) to meet their students' expectations. In response, Bob and Rose spent a significant amount of time coming up with exciting and engaging activities during their daily planning.

In spite of Bob's extraordinary attempts to create a student-centered classroom context, there were some students who persistently expected book-oriented science instruction. Bob recognized that this type of student is most comfortable reading the book and outlining the chapters as a homework assignment. This kind of student learning was

entirely against Bob's teaching philosophy, and he never envisioned having such students in his class. After one week of didactic teaching as a management tool, some of his students approached Bob and told him that they actually learned better from bookwork. Rather than modifying his typical approach to teaching, Bob accommodated those students' needs by allowing them to do book-work as supplementary learning activities to their major classroom learning. His intention was to help these students by supporting their familiar approaches to material but requiring them to take ownership of their sense making.

In terms of students' capabilities in learning science, Bob came to understand that every student was capable of learning as long as teachers provided them effective learning experiences to accommodate their needs, finding alternative teaching approaches when necessary. For Bob the most readily apparent and practical sign of students' lack of learning was their disinterest in classroom activities and classroom discussions. When Bob recognized that students were fairing poorly in his course, he approached other teachers of these students. He began to realize that many of the students who perform poorly in science also performed poorly in other classes. Bob noted that these students were frustrated in the school environment and they often struggled in any classes.

Additionally, students' absences appeared to be another indication of students' struggle in learning science. Students who often missed classes became concerns of Bob, since it quickly became very difficult for such students to catch up with the rest of the class, given the activity based nature of Bob's teaching. Although he did not closely investigate the parents of these students, through discussions with other teachers, he came to understand that these students were mainly from homes where school was not valued.

Usually, these students' participation in classroom activities was very limited. They did not follow Bob's instructions and they did not tend to ask question. When they did ask questions, the answers that they received from Bob did not satisfy their immediate needs as Bob was reluctant to give an answer to student questions. Rather, he preferred to respond by supporting their own sense making, asking things such as "Ok, how can we figure it out and what is going on here" type of approaches. (B/02/27/06/ P. 3) In this case where Bob recognized that he did not effectively help such students in class, he individually communicated with these students after class time. He attempted to

give these students make up opportunities to take the test and extra assignments so that they could catch the regular class level. However, the remedies that he could offer for these students were limited because of his other responsibilities. As a first-year teacher, for extreme cases such as students with attendance problems, he communicated with other teachers and guidance counselor to help these students via the network of the school community.

Surprisingly, there was also a certain type of student who behaved well and showed appropriate participation and achievement in his class; however the same students showed poor performance and persistent underachievement in other teachers' classes. Because of his personal characteristics and the active nature of his classroom environment, Bob understood that these students' personal characteristics gelled well with him. He observed:

I think a lot of it is the way you treat them. I think a lot of it is first impression, too. There is one kid that is notorious on this hallway for the way he treats teachers, but I did something that first week of school, and he likes me. So, now he listens to me. If I say sit down, he sits down. If I say stop talking, he stops talking. But I don't know what I did to this kid. (B/02/27/06/ P. 6)

His emphasis on NOS and science process skills was evident. He explained his ultimate goal in teaching:

So if they get out of here with the science skills, then I consider myself an effective science teacher. And if they get out of here with the basic understanding of physics, and chemistry and I consider myself as an effective physical science teacher. (B/11/10/05 P.8)

Bob's work helped his students to recognize the real life applications of their classroom learning. For Bob, emphasizing the real life aspects of science was a central feature of reform. Bob understood that the most important purpose of high standards was to enable students to observe and meaningfully describe how their science learning relates to other subjects and their daily lives. He noted "I think once you get a concept, the high standard comes from being able to apply that concept, and... the integration where you get the application of the concept." (B/11/10/05 P.4) To ensure successful implementation of reform in science, he worked to "get students to organize their thoughts scientifically and

then be able to communicate [their thoughts]” and eventually find connections to apply their learning to their lives. (B/11/10/05 P.4)

Changes in Bob’s Self-Efficacy

Echoing his teaching self-efficacy at the outset of the year, at midyear Bob’s teaching self-efficacy remained high. Through placing detailed emphasis on his content knowledge, pedagogical knowledge as well as his outcome expectancy, this section outlines the changes that happened in Bob’s self-efficacy during his first-year teaching. In spite of the changes explicit in his outcome expectancy, his overall first-year personal science teaching self-efficacy was high. Bob’s effective first-year teaching practices helped him to maintain his high self-efficacy beliefs as well as his reform-minded teaching practices.

Personal Science Teaching Efficacy

Similar to the previous case, an investigation of changes in Bob’s personal science teaching efficacy revealed that Bob’s content knowledge and pedagogical knowledge played a significant role in shaping his personal teaching efficacy. The following sections provide a close look at the interactions between Bob’s self-efficacy and his content and pedagogical knowledge correspondingly.

Interaction between Self-Efficacy and Content Knowledge

Bob continued to have a high self efficacy in terms of his science content knowledge. He saw himself as capable of designing and explaining science activities, and he saw himself as capable of anticipating students’ questions. On the other hand, since the middle school physical science content covered some chemistry content, students’ chemistry questions and misunderstandings sometimes challenged Bob. His approach to such questions and moments revealed that Bob did not position himself as the ultimate authority in the classroom or as the one who knows everything. When he felt that he had limited knowledge about a part of the content, he shared this with students. For example, during the unit on the Periodic Table, which indeed was not one of his favorite units, one of his students asked Bob why the lanthanide and actinide series were located separately on the periodic table. After his student’s question, Bob paused few seconds and he replied

that he knew the reason why were they located differently compared to other elements on the periodic table. However, he continued by explaining that he was not sure about the exact answer at the moment, and he turned to me asking if I knew the answer to the question. After my response to the question, Bob turned back to his student and asked if my answer was satisfying for her. This incident illustrates that Bob was open to new ideas and that he did not hesitate to go to other sources to provide students with the most accurate physical science content.

After his initial weeks in teaching, Bob often allowed his students to struggle with their own questions, and rather than giving them answers, he preferred to help them to discover their own answers. For Bob, the students' own discovery of answers to their questions was the center of effective science learning. Thus, because of his high self-efficacy in physical science content, Bob was comfortable responding to questions with questions. His high content knowledge self efficacy allowed him to understand that his primary responsibility was to facilitate a learning environment where students are supported in seeking answers to their questions.

Interaction between Self-Efficacy and Pedagogical Knowledge

During his first year, Bob saw himself as a teacher with the necessary skills and knowledge to teach science. He also saw himself as effective in monitoring his students' learning as well as searching better instructional practices to address students' needs. His self-efficacy in terms of his pedagogical knowledge remained high during his first-year teaching. Thus, when during the course of his first year, he realized that he was not being effective, Bob tried various alternative teaching strategies better support his students' science learning:

I think I tried to push until it was obviously a lost cause until, until I exhausted every possibility of teaching them. If I just didn't succeed in teaching them something then I didn't succeed. I think you have to push and push because if every time they come up with something that they are trouble with then you back off, then they're gonna get the idea that "Ok, well it is ok for me to fail. It is ok for me to give something to half effort you know and then back off, and teacher is gonna make it easy for me anyway." But then if you push them, push and push,

they're gonna I think get more of a mentality that "Well I got to work for this because the teacher is not gonna back off of me." (B/04/03/06 P.6)

In the quote above, Bob's emphasis on high expectations was also evident. As a result of his eagerness to put his best effort to teach science effectively, Bob encouraged his students, working to enhance their motivation in learning science.

Besides his high self-efficacy in motivating his students to achieve high standards, Bob also had a high self efficacy to help his students become interested in science. During his first year, Bob took great pains to facilitate group work as a means to increase student motivation and enjoyment. It became a common practice for Bob to have each small group "report out" to the entire classroom community. Students clearly enjoyed and were engaged in such discussions, and Bob saw this as a mechanism to make even "dry" material more engaging.

Outcome Expectancy

Bob's outcome expectancy beliefs posited a strong relationship between the effort exerted by teacher and student achievement in science. Bob understood that if he worked to teach science effectively, his students would learn science. Bob continued to think that the inadequacy of a student's science background could be overcome by effective teaching.

That said, Bob did recognize that many other factors might also influence students' achievement in science. This was a new realization that developed during his first year. He began to see that a teacher's attempts to find the most effective teaching approach by itself did not guarantee all students' high achievement in science. Thus, in his first-year outcome expectancy beliefs, Bob described that the low achievement of some students (especially the ones with low motivation) could not exclusively be blamed on their teachers' effectiveness. Bob came to an understanding that teachers with effective science teaching abilities might not be able to help some unmotivated and uninterested students to learn science. Bob began to understand that the home structures of some students influenced their students' low performance and underachievement. For Bob, the home lives of these students did not reinforce or allow for their success in their school. He noted "If I say do your homework, it doesn't mean anything when parents don't ask

them to do so.” (B/02/27/06/ P. 7) Thus, Bob observed, in order for his attempts to get his students become successful students, parental reinforcement for their children to be successful at school was also necessary.

During his first year at Lake Middle School Bob recognized that he was especially successful teaching science to students who had the life experiences similar to his own. On the other hand, the students who had experiences with which Bob was not familiar posed a particular teaching problem for Bob. He came to understand that it was difficult for him to be successful with such students during his regular class hours. So, he opened his classroom after class hours. It was not unusual to see groups of students studying science in Bob’s class during his planning time. Bob grouped the timing of the visits of these students based on their knowledge and needs so that he and they could focus on what they need to know.

By mid-year Bob became more explicit that students’ willingness and openness to learn in his class was also very important if he were to achieve his teaching goals. He explained:

You can have a kid in school all day but if they’re not interested in learning anything then they’re not gonna learn. You cannot open their head and pour the information in. So, the kids have to meet you half way. If they don’t want to learn, they’re not going to. And nothing I do is gonna make them learn if they just don’t want to. If they’re interested in I mean then I think they can, so I think that there are some that no matter how you are. (B/02/27/06/ P. 8)

Therefore, his responsibility as a science teacher was to create and maintain a learning environment and facilitate appropriate approaches and methods to provide all students with effective learning experiences in his class. And for the best result, Bob also came to an understanding that students also needed to be open and willing to learn along with their parents’ positive motivation for them toward school and learning.

In summary, Bob understood that his preservice education provided him with the essential skills and theoretical background crucial for effective science teaching. Besides his overall satisfaction with his theoretical background, it was also evident that the student-centered and activity-based nature of Bob’s teaching made a great impact on his students’ interest in his class and particularly in learning science. He indicated “I would

say all of the students enjoy coming to science class. I mean they may not enjoy taking the test and taking notes. I mean relatively speaking I think this is pretty enjoyable class.” (B/04/03/06 P.2) Interestingly, in his relatively short time at Lake Middle School, Bob had a reputation among the students about the engaging nature of his classroom context. During my observations, there were several of 6th and 7th grade students who stopped by to check on what sort of activities Bob had planned for the day. It was also common to hear his students’ voices in the hallway during his classes. Their voices were excited, playful, and upbeat. Based on his students’ reactions, Bob maintained his high self-efficacy during his first year at Lake Middle School.

Changes in Bob’s Pedagogical Discontentment

As we explored earlier, despite a slight diminishment of his outcome expectancy, Bob maintained high personal science teaching self-efficacy beliefs during his induction year. Paradoxically, during this time Bob also became more critical about his teaching, searching for aspects of his teaching that needed improvement. In other words, by mid-term, Bob began to experience a mild pedagogical discontentment. The following discussion explores Bob’s first-year pedagogical discontentment through examining specific aspects of his teaching.

Changes in PD for Teaching Inquiry-Based Science

As has been described, Bob’s overall first-year teaching largely featured student-centered and inquiry-based science teaching practices. Bob worked to create and maintain a well-managed classroom context in which his students knew their roles as learners. He achieved much of this through his early emphasis on NOS and inquiry skills within the context of clearcut classroom management. The pattern set in this NOS unit held for much of the year, as students grew accustomed to evaluating their learning through the six science process skills:

Whenever we do an activity at the end of it, we try to go back to the six words over here. The science process goes and say “ok, did we observe? Where did we observe in this activity, what did we observe? Did we predict? Where did our predictions come into play? What did we predict? So I think by introducing it at the beginning, and then revisiting it all throughout every time we do a lab, and

every time we do an activity. Then I think that it sort of becomes their way of thinking. So maybe next year when they go to science class they'll be in the habit of predicting, and inferring, and realize what they are doing as they're doing that. (B/11/10/05 P.8)

Established within the NOS unit and maintained throughout the year, Bob's approach to classroom management could be best summarized by the motto he emphasized to his students: be respectful, responsible and safe. Most of his students were cognizant that Bob was observing them and many behaved accordingly

Throughout much of the year, Bob continued to structure his teaching around student-centered activities, and students continued to benefit from this. However, it was sometimes very difficult for Bob to find and facilitate inquiry-based activities because of the time constraints and mostly the nature of content that he taught. For example the unit on the Periodic Table was a real challenge to teach via inquiry. But instead of capitulating to the difficult, Bob invested time in a long brain-storming session with Rose, in which they decided to create a huge Periodic Table on his classroom wall. Each student was assigned to learn the characteristics of several elements from this table and to place those elements on the wall in the appropriate time during the course of the unit. For instance, when they were talking about metals, students who studied metals placed their elements on the wall, based on their atomic numbers.

In spite of his ardent attempts to teach the periodic table through students' active participations and inquiry-based nature, this unit was more teacher-centered than most. As he reflected on his midterm teaching practices, Bob realized that he used didactic instructions more often compared to his earlier teaching. According to Bob "I think...sometimes I think about what I'm doing and why I'm doing it and a lot of times I find myself being more didactic than what I want to be." (B/02/27/06/ P. 1)

Being a soccer coach and prioritizing the curriculum mandated by the state were some of the aspects that prevented Bob from achieving his teaching goals in his practice. He expressed "...being in our crunch and being at the end of soccer season [he was the soccer coach for boy's team last semester and girls' team this semester], [the achievement test] coming up, and just my own being lazy we didn't do well." (B/02/27/06/ P. 1) It was

evident that contextual and personal aspects of Bob's teaching context influenced his practices toward more traditional patterns.

It was his pedagogical discontentment that kept him searching for ways to improve his practice, to attempt to achieve his teaching goals. Although he sometimes taught science through didactic and confirmatory teaching style, students' own discoveries were still the center of his teaching context. Bob attempted to provide opportunities for his students to "do their own discovery" and after each activity, Bob used whole class discussions about his students' individual discoveries about certain science topics. (B/02/27/06/ P. 1) Therefore, in spite of the non-inquiry nature of some of his classes, he was relatively selective about including the activities that intellectually engaged his students. For example, in one of his classes, he wanted his student to prepare a mini book on machines in which students used their textbook and other possible outside resources to prepare a handbook on machines. Although this activity was not an exciting, inquiry-based activity in both his and his students' perception, it was a way for students to engage with the material. Too, for Bob, this activity was more effective than lecturing the entire unit and asking the students to take notes on his lecture.

By mid-term, it is important to recognize that Bob's attempts to understand and address his students' prior misconceptions in science were limited. However, his occasional use of mind maps seemed to provide a lens to understand students' misconceptions of their current science learning, but he did not extend this process to understand their misconceptions at the outset of a unit. His use of mind maps (different from the structured ones employed in the text) involved having students read the text and based on their understanding, constructing a map showing how different terms were related: "The purpose of making a mind map is making the connections in their head and if they're already made on the paper." (B/06/28/06 P.8) After retrieving their mind maps, Bob graded them and posted them on the classroom walls. Grading these maps were an opportunity to highlight the sections where his students failed to understand and further focus on these points. Interestingly, this was the only use of the textbook in Bob's class for instructional purposes (other than planning purposes).

Bob did experience mild pedagogical discontentment at midyear as he reflected on the amount of inquiry he was able to employ. His reaction to this discontentment

resulted in increased planning that resulted in more student centered teaching, even when the nature of the content made inquiry a seeming impossibility.

Changes in PD for Teaching across All Student Ability-Levels

Bob understood that much of the success of teaching across student ability levels stem from the “climate” of a classroom. He understood that his classroom environment was very motivating for students because of the activity-based nature of his science teaching. Bob was very satisfied with his classroom climate during his midterm at Lake Middle School. Bob explained:

I think most of the kids enjoy coming here. I mean I remember when I was in school there would be the one class that I hated to go to and the one class that I look forward to every day. And I think because you do so many activities so much stuff, they’re always wondering “Ok, what are we gonna get to do in Mr. Hanna’s class.” (B/04/03/06 P.5)

For Bob, based on their achievement and their gains in terms of learning science, students who were “independent” and “didn’t mind not having a clear way of doing things or having correct answers” were the most successful students in his classes. (B/06/22/06 P.4) Students whose learning depended on having directions and right answers from their teachers seemed to be the least successful students in Bob’s class since Bob did not practice teacher-centered, confirmatory science teaching. During the year, these students seemed to struggle to make sense and were hesitant to express their thoughts openly because they were afraid that their answers would be “wrong”. Bob encouraged these hesitant students to share their thoughts since communication of ideas was a central activity of science as performed in Bob’s class.

By mid-term, Bob came to realize that some students were more comfortable learning through book-work and homework. In one of his classes when classroom management became a concern, Bob “punished” them by replacing activities with book-work and homework. Afterward, he noted that some of his students’ performance on the test was quite high compared to their previous performance. However, the increased performance of these students in test scores did not change Bob’s perception about science teaching. Bob believed that the best way to teach science was to allow students to

learn science through the process of science and inquiry. Thus, he did not envision himself basing his teaching on book-work and homework assignments. But to adapt a teaching strategy for students who craved the regularity of books and lectures, Bob allowed these students to complete section reviews and outlines as supplementary activities to support their learning.

It is important to note that because of Bob's limited and optional tolerance for book-work and section reviews, he continued to emphasize to all his students that his role as a teacher was not to give them specific directions for procedures or "right" answers. His role was to provide for them the necessary tools for them to learn the content. Through the midterm, it was evident that he was successful structuring a learning culture in which his students were aware of his role as a facilitator. Students came to expect Bob to answer their question with his question: "What do you think?"

Another strategy Bob used to teach students of different ability levels was group work. In his first year at Lake Middle School, Bob's worked to enhance his students' comfort level in participating in small group activities. It was evident that almost all of his students, including the ones who accustomed to traditional book work, enjoyed the group work. The exceptions were the students who consistently disrupted class. Bob struggled to place these individual students in groups where they could work with others in harmony. Throughout the mid-year period, Bob experimented with different group arrangements to maximize students' learning. He intentionally kept the group of students with low ability and misbehavior near his desk. He grouped some of his misbehaving students who were all boys with girls who seemed to have more responsible and mature personalities and high achievement in his class. Interestingly, this approach seemed to work, allowing the entire class to become more focused and interested by the end of the school year.

As far as his ability for orchestrating a balance between the needs of both high and low ability-level students, Bob did not want his high level students to think that Bob was ignoring them while he needed to invest special attention in misbehaving and low performing students. Bob stated that he did not like his teachers to pay more attention to "trouble makers." He attempted to prevent this tension through visiting and paying

attention to all groups equally during his teaching, and he always walked between the groups and tried to communicate with his students either as a group or individually.

In spite of his strategies to provide best science learning experiences for all of his students, Bob also realized that there were several of his students who were constant underachieving students in his teaching context. Bob perceived that the reason for these students to perform poorly in school was because of their “attitudes towards life.” (B/06/22/06 P.5) According to Bob, these students were not aware of the importance of the school. They were largely focused on their social well being in school through socializing with other students and being a “cool kid rather than learning.” (B/06/22/06 P.5)

Bob saw himself as a teacher who was successful on a daily level at teaching all students, not just the high achieving and not just the low achieving. He understood that some of his lack of success with the lowest achievers was due to contextual factors that were largely beyond his control. But Bob did take responsibility for his lack of effectiveness, and his mid-pedagogical discontentment caused him to subtly alter his instruction to better suit his students needs (i.e., the inclusion of text reviews for some, the experimentation with different group configurations for others).

Changes in PD for Resolving Depth vs. Breadth Content Issues

Bob experienced the greatest pedagogical discontentment in his effectiveness in resolving depth versus breadth issues in his teaching. Bob consistently employed “bell-work” activities to establish necessary connections between physical science and students’ daily lives. The questions that Bob asked as bell-work often addressed daily life phenomenon that students could easily observe. For example, for the unit of Bernoulli’s principle began with a bell work question: “One day my mom’s car window got stuck in the “down” position. I covered it with a clear plastic garbage bag and taped it down tight. However, when we started driving the plastic stuck out of the window like a bubble! Why?” (OB 04/05/06) In another bell-work question, Bob asked his students to explain the role of a spoiler in cars.

After each bell-work activity, Bob facilitated an entire classroom discussion about the physical scientific aspects of the questions, and he expected his students to report

their responses to the question in a written format the day after the class. After collecting student's bell-work reports Bob read each students' reports to evaluate if there was any major misconceptions with the students' understanding of the questions.

Bob worked to incorporate instances of everyday science throughout this teaching. For instance, in the unit of air pressure, Bob realized that some of his students struggled to understand the relationship between high and low pressure. Bob brought up a real life situation to help his students to visualize the concept:

Bob: "What do they tell you to do to your windows during the hurricane?"

Students: Crack them

Bob: Why?

No answer from the class

Bob: If I got a house and it is all shut in, imagine a square house and I am bird looking down on it. [He draws it on the board]. And all my windows are completely shut. Where is the air moving? Is it moving inside?

Students: No outside.

Bob: It is moving outside right! So, I got air blowing by outside of my house. So, where is the high pressure where is the low pressure?

Student: High pressure inside and low pressure outside

Bob: High pressure inside and low pressure outside because the wind is mowing real fast. What are the windows gonna do?

Student: They are gonna wanna be like plastic bag did yesterday's bell-work. They're gonna blow out. (BO/04/07/06)

As far as his first-year practices in balancing his personal science teaching goals with those of state and national standards as well as state testing requirements, Bob was a firm believer in standardized and accountable education. Thus, the state standards played significant role in guiding Bob and Rose to what to teach to their students in most of their curriculum practices.

As opposed to his relevant practices with state standards, Bob did not regard and take into consideration the state testing requirements as a determining factor of his teaching practices. He simply believed that if his students effectively learned the state standards, the state's testing would not be difficult. Indeed, in his practices, except for the

week of state achievement testing, Bob did not devote any time for preparing his student for the state achievement test.

Bob worked to extend his practices to broaden his students' understanding of science toward achieving high standards outlined well in NSES. On one occasion, he realized that his selection of reform minded unit was not successful. For instance, although the State Standards did not emphasize the unit of Measurement, Bob and Rose thought that the Measurement unit might be beneficial for their students and their understanding of the unit might enhance their grasp of other physical science units. Indeed, considering that the majority of physical science topics required a vast amount of conversions, their idea was reasonable.

However, in application, Bob realized that his conceptual grasp of measurement was not the same as that of his students'. Bob noted: "I guess it's something that once you've mastered it, it's so easy that you don't even think about doing it." (B/02/27/06/ P. 1) In spite of the effort, time and care devote to planning this unit; Bob realized that it was a failure. Bob observed:

Not only couldn't they read the ruler but they couldn't convert on top of that. And it just became one huge disaster. So, now when I give them test I don't make them convert yields. And when I have them do an activity where they have to measure, I really watch them to make sure they're measuring what they are supposed to.

The conversion was something that we thought was cool, it was important, and it just didn't go well at all. (B/02/27/06/ P. 1)

As he described, the Measurement unit turned to be "a disaster" in terms of students' understanding of measurement and conversions. (B/02/27/06/ P. 1) This unit was one of the most noticeable failures in his first year in teaching in terms of his students' learning. Bob understood that this failure had two causes. For one, the students were not familiar with the Universal metric system. Naturally, they were accustomed with English system. Another reason that Bob highlighted was his misunderstanding of his students' abilities to understand the mathematics embedded in the unit. Because he misgauged both of these factors, the unit was not effective. Bob took ownership of this failure, and continued to muse about what could be changed for the following year. Thus, his goal of enlisting a

deep understanding of measurement served as an instance that evoked a strong sense of pedagogical discontentment.

Changes in PD for Assessing Student Learning

Including both formal and informal assessments, Bob used various assessment strategies to ensure the effectiveness of his teaching and his students' effective science learning experiences during his first year. As far as his formal assessment practices, Bob monitored his students' understanding of physical science content through traditional assessment practices including test and homework assignments. His homework assignments included mind maps and bell-work reports. As described earlier, Bob used mind maps to better understand his students' conceptual grasps of a unit to inform his planning, and used bell-work activities to tie students' science learning to their everyday lives.

Each unit culminated with a formal test. The unit tests had approximately 50 questions in two separate parts. The first section was from the teacher version of the textbook's unit review, which included multiple choice, word bank and open-ended questions. In terms of the second part of the test, Bob asked open-ended questions that highlighted the main issues of the unit. After administering the tests Bob graded his students' performance on the tests, and he returned his students' test results to them. In addition to serving as a source of information for his students, the test results were a crucial reference point for Bob. Those items that most of his students missed were retaught before beginning a new unit.

Interestingly, however, Bob did not use the test results as a major evaluation tool for the effectiveness of his teaching. He understood that his students' test performance did not solely reflect their learning. He explained:

So if I base my success as a teacher on how well my kids do on test then I'm not getting the whole picture. If I'm a good teacher they're gonna enjoy my class. So, if they've got smiles on their faces and you know they enjoy participating in what we're doing that is part of it. If they know enough about what we're doing to ask good questions about it, that is perfect. (B/04/03/06 P.6)

Thus, in terms of his effectiveness as a science teacher, for Bob there was no significant correlation between his effectiveness and his students' performance on the tests. His judgment on his effectiveness was mainly based on his informal assessment techniques such as his observations over his students' reactions and their willingness as well as their questions about the content. In his first-year teaching, Bob continuously assessed his students' behaviors and engagement. He specified the significance of his informal assessment approach as the following; "If you get the disinterest or kids are just sitting there, they put their pencil down, and they're not worried about doing it. If I go way over their heads and nobody understands what we're doing." (B/04/03/06 P.6) Thus he came to understand the importance of constant observations of his students' behaviors to assess the effectiveness of his teaching.

Based on these informal assessments, Bob sometimes found alternative activities to enhance students' understanding. He sometimes repeated that activity one more time. For example, during the week of air pressure unit, Bob used several activities to teach Bernoulli's principle. After assessing his students' reports on the activities, Bob realized that although many of his students enjoyed these activities, they did not illustrate an appropriate grasp of why and how aspects of the activities in their reports. Thus, he conducted these activities one more time and supported this by a very thorough discussion of the material afterwards.

Although his use of assessment seemed to be a crucial part of Bob's first-year teaching, assessment was not a major concern for Bob. Thus, he experienced little to no pedagogical discontentment in this aspect of this teaching.

Changes in PD for Bob's Level of Science Content Knowledge

As discussed earlier, Bob received a strong background in physics during his college years. Too, his initial goal was to teach high school physics after his teacher education program and he emphasized learning the necessary skills to teach physics for high school level students. Thus, it was evident that Bob had sufficient content knowledge to generate lessons for his students during his first year at Lake Middle School. His strong background became more apparent during his planning practices.

Bob's deep physics background helped both Rose and Bob to generate well-designed, effective lesson plans.

In spite of his success in generating successful physical science activities and lesson plans, Bob's strong background in physics sometimes led Bob to include more complex physics terminology than appropriate with middle school students. It was obvious to Bob that those moments caused his students to disengage from his teaching. On the other hand, students' seemed to become familiar with his use of higher physics terminology in his teaching and by the end of the school year, his students used Bob's use of higher physics concepts as opportunities to make fun of him.

Although he was unfamiliar with physical science content and his lack of experiences in teaching, especially in teaching physical science content, sometimes challenged Bob and his preservice learning, after starting his first-year teaching, Bob gained a better understanding of the abilities and skills of middle school students as well as the physical science content.

Thus, again Bob experienced a mild pedagogical discontentment in terms of his content knowledge for teaching physical science. By mid-year, he began to see that his deep knowledge of physics at times prevented him from engaging with his students. Too, his deep knowledge of physics was in need of broadening as he worked to become a physical science teacher.

In terms of overall pedagogical discontentment, although he was able to teach science for all students, by the midterm Bob realized that he needed to have an appropriate amount of experience to teach science effectively for the students with behavior problems who were also consistently low performing students in his teaching context. As far as those low performing students, as their teacher, Bob defined that regardless of the students' previous experiences, teachers had the primary responsibility of the students' low performance and their underachievement. Bob contended:

I think there are skills that if they're not taught, it puts the kid at a disadvantage. You know if I don't teach them modestly, when they get to high school, they are gonna be at a disadvantage. But I don't think it's my place to say "Well you suck because you didn't teach these kids." [I mean if they don't know that they need know it in my class]. Then maybe I have to pick up the slack but it's not

something where I'm looking to blame somebody. Because I mean I can blame all the people I want to, but it's not gonna teach the kid the concepts. (B/02/27/06/ P. 7)

Thus, Bob realized that he needed to work to become a more effective teacher in many regards--in terms of his content knowledge, in terms of the depth-versus-breath issue and in terms of teaching all students. But in each of these categories, these were mild discontentments, but strong enough to invoke some movement toward change.

Bob's Final Beliefs

In the following section we will explore Bob's final beliefs about science and science teaching in detail and how his first-year beliefs played a role in shaping his final teaching practices.

Bob's Final Beliefs about Science

Similar to his previous definition, Bob defined science simply as all about posing questions "why do we see this" and searching "what causes that" through the scientific inquiry. (B/06/28/06 P.1) As parallel to this definition based on the nature of science, Bob believed that the teaching of science should revolve around questions. During his first year, Bob mostly facilitated his teaching with the questions, sometimes his students', but mostly his own questions. There were times in which the content was so abstract, students were at a loss to pose questions, and in those times Bob quickly jumped in with his own. This semi-structured nature of the question posing not only helped his students but also helped Bob with his classroom management.

From the first day of his teaching till the last day, Bob emphasized the importance of his students' understanding of Nature of Science for effective science teaching. In his perception, the goal of the Nature of Science activities were to help students better understand science and the importance of scientific inquiry in learning science. Bob indicated the purpose of the [NOS] class is to get [students] to be able think on their own versus 'I got big words [in this book or internet] so it must be true'." (B/06/28/06 P.9) Throughout the year, he used NOS to urge his students to evaluate and question the science they learned.

Bob's Final Beliefs about Reform in Science Education

Science education reform implementations dominated Bob's first-year practices at Lake Middle School. Within his reform-based teaching context, Bob attempted to teach science through inquiry-based and student-centered nature. Thus, by the end of his first year, Bob seemed to have a broad understanding of the difference between reform-based science teaching and traditional science teaching approaches. He indicated this difference as following

You know memorize these things versus really understanding that it is about asking questions and looking for answers not just in the book but from what you observe and from what you can you know put together on your own. (B/06/28/06 P.2)

Therefore, by years end, he came to a deeper understanding of the utility of reform-based practice in supporting his students' science learning.

His teaching specifically helped his students to structure their own learning by using various resources available and learning science became relatively enjoyable for them in Bob's inquiry-based classroom. In Bob's beliefs, his students' enjoyment and learning were an integral part of effective science teaching. Because of his emphasis on student enjoyment in his class, many of his students, including typically unmotivated ones, seemed to be engaged in Bob's classes.

Bob's Final Beliefs about the Standardized Achievement Test

Bob's beliefs about standardized testing and its role in school remained constant through year school year. He continued to see the test as valid tool in order to establish and ensure a common ground for the minimum and necessary knowledge that each student should learn in their science classes.

With regard to his perception about the state standards and the state achievement test, according to Bob, his preservice education program provided the preservice teachers with a proper insight for the state standards and their importance. On the other hand, the weakness of the program was its position toward the accuracy and validity of the state achievement test. Bob indicated that the program was skeptical about the achievement test, and they delivered a message to the preservice teachers that the achievement test was

not a valid tool to measure student learning. However, Bob perceived that a more “objective” look at such tools would better assist preservice teachers in exploring and analyzing the achievement test questions.

Although he complained about the lack of emphasis on the state achievement test during his preservice education, or the program’s negative perception about it, the sources of his current beliefs about the state achievement test was one of his methods courses in his preservice program. During his one of the methods courses he participated in a research group where his group closely examined the state achievement test at the state’s department of education. He explained:

And we learned a whole lot about the process... You know, the faith that I have that [the achievement test] is valid comes from that process. So, I think yeah it would be great for undergraduates to have that opportunity so they don’t just come in, because people don’t know whole about the test. So, automatically they say “I don’t like the [achievement test]!” They can’t tell you why, and if they can tell you why; it’s gonna often like “Oh these questions are biased.” (B/02/27/06 P.2)

Bob was quick to note that the state test required written answers, and did not consist solely of multiple choice questions. Too, he pointed out that the science section of the state achievement test also had questions specifically focused on the process of a scientific problem rather than the short answer. These examples were Bob’s evidence that the state achievement test consisted of various approaches to measure student learning-- thus further supporting its validity.

Given his school’s history of strong performance on these assessments, Bob continued to understand that the best way to prepare for such a test is to do a thorough and effective job teaching to the standards. Test preparation was not a concern of Bob and it did not become one during his first year of teaching.

Bob’s Final Beliefs about Science Teaching and Learning

Overall, Bob perceived that he was able to teach science effectively during his first year. To be an effective teacher, he specified that his sense of being responsible for his students’ learning was his most important strength. In addition to that, his rapport

with his students and the mesh of his personal characteristics and background with his students were also other strengths that helped Bob to be an effective beginning science teacher at Lake Middle School.

Bob stressed that an effective science teacher needed to provoke his/her students' curiosity. Bob generally created this curiosity through bringing up the daily life applications of a subject with exciting general classroom discussions. To act on this belief, Bob continued using bell work and providing supplies for students to "play with: so that the students would come up their own questions about an activity" (B/06/20/06 P.1).

Bob also emphasized that teachers needed to facilitate a learning environment in which teaching and learning was a focal point for both teachers and students. At the beginning of his first year, Bob successfully set up his effective classroom environment by facilitating classroom rules, and he managed to maintain this learning climate during his midterm teaching at Lake Middle School. However, at the end of the school year he perceived that his classroom management became very weaker, and he became more lackadaisical when it came to management. It was evident through observations that the comfort level in his class encouraged some of his students to misbehave and distract the entire class. Bob envisioned that next year he needed to address this issue through being more consistent with his classroom rules. He specified that his weakness of management did not require him to be strict, rather he believed that being more consistent and applying his classroom rules would allow teaching and learning to be the main focus.

Bob's beliefs about learning did not change during the year of teaching. In short, he understood at year's end that for effective science learning, it was critical for students to "make mistakes" and "go through their own process of figuring out what works and what doesn't work." (B/06/20/06 P.1) Bob realized that being an effective science teacher required one to be patient and allow students to learn science through their own, sometimes flawed, attempts.

Bob Final Self-Efficacy

As far as Bob's final term self-efficacy, the analysis of his personal science teaching efficacy and science teaching outcome expectancy, by the end of his first-year

teaching Bob illustrated a relatively high self-efficacy. Compared to his earlier preservice experiences, Bob explained: “I felt more confident, more independent I guess. I started to feel like I was a real teacher instead of just a college student in someone else’s classroom.” (B/06/22/06 P.1) His confidence as a beginning teacher was also explicit in his practices. The level of patience that Bob showed for his students to make mistakes grew over the year. Bob became more comfortable teaching via inquiry. Bob also improved his skills in finding appropriate questions to guide his students’ learning, moving further away from simply telling them directions.

Bob’s Final Teaching Self-Efficacy

An investigation of Bob’s final personal science teaching efficacy revealed that Bob’s content knowledge and his pedagogical knowledge played crucial role in molding his teaching self-efficacy.

Interaction between Bob’s Final Self-Efficacy and Content Knowledge

Bob’s first-year teaching confirmed that Bob had an excellent understanding of physical science content and could teach it effectively. It was also obvious that Bob was able to effectively monitor his students’ learning of physical science concepts. One result of this well established self-efficacy was that by year’s end, Bob became more confident in letting his students try their own solutions to resolve questions and problems that arose. He became more patient, prompting students with further questions, and holding back direct answers. He learned to challenge his students to guide them to their own discoveries.

Interaction between Bob’s Final Self-Efficacy and Pedagogical Knowledge

Bob’s teaching self efficacy echoed those beliefs at the very outset of his teaching. Bob continued to have high self-confidence in his teaching. Bob thought of himself as a teacher who was able to teach science for all students, and he was confident about providing science instruction that responded to his students’ specific needs. He noted:

I think the reason I feel successful is because the way I was able to bond with the students. And once we developed this relationship then we were able to focus on

the science as a cooperative group. I give you work to do, you spit it back and we learn about this notion. I felt like that that part was really successful. It is not necessarily the achievement scores. I felt more successful in getting the kids to enjoy what we were doing. (B/06/22/06 PP.1-2)

For Bob, among others, the most successful teaching period in his first year at Lake Middle School was the Physics Olympics held at year's end. After the week of the state achievement test, Bob and Rose organized Science Olympics between their classes. During these activities, students from the two classes competed with each other through science related activities such as air plane construction, roller coaster construction, and the egg drop. For Bob, this activity was "a fun way" to end the school year. (B/04/03/06 P.1) Besides making science classes enjoyable, teachers selected the activities to allow students to apply what they had learned with everyday materials. Since Bob and Rose had already "covered" the entire state standards by this point, they were able to devote final six weeks of the school for this activity. Bob's high teaching self-efficacy was further bolstered by the effectiveness of this event (as measured by student engagement and enjoyment), and he continued to consider himself a very effective science teacher.

Bob's Final Outcome Expectancy

Outcome expectancy was one area of Bob's self-efficacy that was relatively malleable during the school year. Specifically, at the beginning of the school year, Bob understood his students' achievement in science to be directly related to his teaching effectiveness. By midterm this belief had shifted, and he came to understand that teachers were not solely responsible for their students' science achievement. This belief was retained through year's end. Bob noted that his students' own motivation and willingness appeared to be the most significant external factors for him to teach science effectively at the end of his first year. Bob explained:

...just some of the personalities of students themselves gave me trouble. I didn't understand the "I don't care attitude" that some of them have. There was a lot fewer than I anticipated had that kind of attitude but when they don't care, I had a lot of trouble to getting them to care. (B/06/20/06 P.3)

Bob came to understand that students were the primary actors in their own learning. He saw that it was teachers' responsibility to facilitate their students learning to help students to take responsibility of their learning.

Within his specific teaching context, Bob realized that the most influential factor for student underachievement was disinterest. According to Bob, it was typical that some students liked one unit and did not like another unit. He saw that there were some students who were perpetually underachieving, not interested in schooling in general:

Some of these kids go home and don't see their parents and when they do there is no academic motivation at all if there is even motivation at all. Some of them I mean really have sad stories about literally having to go home and taking care of their family because their parents can't do it or don't do it. So, for those kids school isn't so important. And science is not important to their survival.

(B/06/20/06 P.2)

Thus, Bob indicated that parents were also important and another group that must be factored into students' science learning.

By year's end, Bob explained that if these chronically disengaged, misbehaving students were taken from his class, he would be more effective teacher and learning in his class would be enhanced. He sometimes argued "n-1 is greater than n." (Personal communication) By this, Bob explained: "I can think of two or three students that I had this past year that actually were removed from a situation. And once that happened then [as a teacher] I was unbelievably better." (B/06/20/06 P.3)

To help these students, Bob was invested in creating and maintaining a personal rapport with his students. At times, this worked, as some of his students took great pains to avoid disappointing Bob. For these students, participating in discussions and completing their homework assignments were more important than learning science. For interpersonal reasons, they engaged with material.

Bob's Final Pedagogical Discontentment

Surprisingly soon after school ended, Bob started to miss his students and his teaching context. During this time, Bob was able to reflect back to his practices over the year. This reflection caused him to critique his practice and to begin to prepare so that he

could improve his teaching the following year. This section will focus on Bob's overall first-year pedagogical discontentments and his plans to improve his science teaching.

Final PD for Teaching Inquiry-Based Science

Looking back, Bob recognized that he mainly employed guided inquiry for his first-year teaching practices. He also noted that his teaching did not involve open-inquiry in which learning was a process of complete discovery by his students. Also it was not a structured inquiry where Bob structured his lessons with a set of sequences and certain steps in which students had to follow his directions to find answers for specific questions previously outlined. Rather, Bob facilitated his teaching context for his students to ask questions and participate in active process of searching answers for the questions. He explained: "I just started doing it. And once they've done it couple of times, it becomes the way we do things. They had a hard time with it first." (B/06/22/06 P.6) He summarized:

They wanna know "Ok, what is the next step? Is this right? Should I do it this way or that way?" And [I was] "Well, I don't know, why don't you try one way and see if it works?" [The student] "How do you know it works" [Robert] "I don't know what do you see? Can you learn anything from that?" So, they want a lot more teacher telling them what to do in the beginning. And then once they're done it for couple of weeks they're able to say "Ok, let's try this. What happens if we do this? And why does that happen?" They're more comfortable guiding themselves versus me guiding them. (B/06/22/06 P.6)

Bob recognized that he became more competent in allowing students to take some ownership in their learning. Early on, Bob seemed to be very impatient in his students' efforts to come up with a useful procedure or answer a question. At the end of his first year, he realized that an effective science learning context required extreme patience on the part of the teacher. Bob also understood that letting his students pursue their own learning sometimes resulted in his students struggling with "superficial questions" (B/06/20/06 P.1) Working to prevent this misplaced effort, Bob usually walked around the class and asked students questions to facilitate their thinking process toward a reasonable base where students were engaged in finding an answer for the main question.

It seemed that because of his lack of experience in teaching, Bob sometimes had difficulty in finding appropriate guiding question for his students. By year's end, he recognized this limitation.

As a first-year teacher, it was sometimes challenging for Bob to come up with useful activities. Bob recognized that he sometimes felt in short of his ideas and activities and he realized how difficult it was to prepare effective lesson plans and activities day in and day out.

By year's end, Bob recognized many of his strengths and limitations in teaching through inquiry. This modest pedagogical discontentment caused him to work for changes the following year.

Final PD for Teaching across All Student Ability-Levels

Bob seemed to be quite contented with his inquiry-based teaching practices. It was obvious that many of his students enjoyed Bob's activity-based science teaching. Hence, his students' overall performance and their enjoyment supported his overall pedagogical contentment. That said, by year's end, Bob came to understand that it was impossible to teach science, entirely through inquiry for all students. He observed that some of his students preferred to learn science through assignments and book reviews. For such students, as discussed earlier, Bob sought out alternative methods, mostly traditional ways, to accommodate his book-work oriented students' needs.

His preservice education placed a special focus on teaching science for diverse student populations as a part of reform in science education. Bob understood diversity to be an important part of effective learning experiences. Bob explained:

I think different groups influence other groups in the school in good and bad ways. But it helps them teach how to interact with different types of people and gets them ready for real world. You're gonna be dealing with all types of people not just the people in your own neighborhood that are just like you. So, I'm a little bit upset that we're gonna lose that. (B/06/20/06 P.1)

Given his overall success with a wide range of students, Bob experienced little to no pedagogical discontentment in this regard.

Final PD for Resolving Depth vs. Breadth Content Issues

Bob recognized his struggle to resolve the depth versus breadth issue in his teaching, a struggle that was magnified in part by his own deep content knowledge of physics.

For example, during the unit of periodic table, Bob was faced with this challenge in which his students did not seem to be as focused to learn the unit as opposed to their motivation in other units. Although he tried to incorporate supplementary activities for such units, Bob's lack of experience to facilitate enjoyable and effective activities for the unit proved to be a huge stumbling block for the unit. In addition to that he understood "there is stuff that you just can't really learn well enough just by looking at activities. You have to look at the book and you know really through the history and see how to communicate those ideas." (B/06/22/06 P.2) Indeed, for Bob it was very difficult to find engaging activities for all physical science units.

One tangible evidence of his successful resolution of the depth versus breath issue came from a class field trip to an amusement part. On a roller coaster ride, when the roller coaster was hurtling down, his students yelled "kinetic," when it was headed up, they yelled "potential" --referring to the type of energy that the roller coaster had. Bob expressed that as a "priceless moment" for him to see his students' use of their classroom learning. He felt successful in allowing his students to see the science in their everyday lives.

Final PD for Assessing Student Learning

At the end of the year, unlike his first and midterm semester, Bob more explicitly focused on whether his teaching was effective and if his students understood the subject that he was teaching. In terms of his understanding of his effectiveness, Bob explained:

If I'm not having to say "Ok, let's get back to work, let's move over here, let's keep going, don't stop, don't give up." You know if that's happening than they're clearly not interested in and they're not gonna learn. But if I can give them something and say go, and they're running on their own then they're obviously interested, and they're obviously learning something from that if they're, you know, focused on it by themselves. (B/06/20/06 P.2)

Bob was able to recognize not only whether his students' learned the required skills and standards but also the effectiveness of his teaching and by year's end, he was content with his abilities in this area of his teaching.

Final PD for Bob's Level of Science Content Knowledge

Bob recognized that he had a sufficient physics content knowledge to generate physical science lessons and to lead thoughtful discussions of activities. As discussed earlier, one of his teaching goals was to help his students to scientifically communicate their ideas with other, thus classroom discussions were the significant part of his first-year teaching. However it was sometimes challenging for Bob to generate effective activities for some chemical science content. His difficulties in this area stuck with Bob, acting as a source of pedagogical discontentment. He hoped that with more experience in teaching, he would develop his content knowledge to the point that this problem would dissipate. For that purpose, Bob and Rose scheduled to meet to discuss how they could improve on their past teaching performance. One of the specific issues that they would discuss was to aid their difficulty in finding and facilitating effective activities across the entire physical science curriculum. Specifically they hoped that GEMS activities (Great Explorations in Math and Science--a nationally recognized and locally employed curricula) would provide a robust source to aid their search.

Summary

For CHAT, change and learning in work and organizations require construction of a new object and new motives through transforming in a profession (Engeström, 1999). As discussed in Chapter 6, what we observe in Bob's first-year activity system was his community oriented identity shaping his first-year teaching practices.

As far as Bob's specific development and transformation in the teaching profession, contradictions that Bob perceived in his first-year activity system played a significant role in providing venues for Bob to develop. A close look at Bob's profound sense of internalization and externalization of his activity system illustrated that changes in Bob's pedagogical discontentment and self-efficacy beliefs provided him with venues to develop essential skills to become an effective science teacher.

Confirming to Laat and Watters (1995), an emphasis on change in Bob's self-efficacy beliefs illustrated that self-efficacy is a useful construct to provide a benchmark for monitoring first-year science teachers transformation and development. Although Bob started his first year teaching with a high personal science teaching efficacy and left his first year with the relatively same high self-efficacy, change in his outcome expectancy was evident. At the beginning of his first year Bob foresaw himself as the foremost individual responsible for his students' learning and achievement in science. During the course of his first year, he understood that there existed several other factors influencing students' science learning including the students' own motivation, and collaboration between teachers and parents. Indeed, the interplay relations among various other factors shaping the effective science teaching and learning helped Bob to understand that for effective science learning, teachers needed to underscore these factors and seek alternative approaches to reach all student ability levels. Thus, this change in Bob's outcome expectancy resulted in a consistent pattern with Bandura's assertion that people adopt internal standards, monitor their actions and use self incentives to mobilize and sustain action (Bandura, 1986).

Along with change in his self-efficacy beliefs, relatively small but profound changes in his pedagogical discontentment cultivated an effective ground for Bob to change his teaching practices mindful of science education reform. Through his self-reflection and cooperation with Rose, Bob became more aware of the mismatch between his teaching goals and his actual teaching practices, which in some cases, caused a mild pedagogical discontentment. By this, I mean that Bob overall was pleased with the effectiveness of his teaching over the year, but he did see areas that were in need of improvement. In order to improve his teaching practices, he was constantly engaged in searching for alternative ways of instructional practices to accommodate all of his students needs during his first year in teaching at Lake Middle School.

Next Chapter will provide a detailed exploration of Bob's first year activity system through the use of CHAT.

CHAPTER 7

THE ACTIVITY SYSTEM FOR THE COMMUNITY MEMBER

Chapter 6 included an analysis of Bob's beliefs associated with science and science teaching, focusing on how these beliefs changed over his first year of teaching and the manner in which these beliefs shaped his enactment of reform-minded science instruction. In this chapter I use CHAT to explore Bob's first-year activity system to understand how this system influenced these changes, focusing on the factors that emerged as most central to this system and their interaction. A summary of the various components of Bob's activity system can be found in **Table 7. 1**.

Subject

As described earlier, as a beginning first-year science teacher Bob positioned himself as a communal, down-to-earth, responsible person. At the center of his first-year activity system, his willingness to learn from others played significant role in shaping Bob's first-year experiences in Lake Middle School. As discussed by many researchers (Gee, 2001; Giddens, 1991; Holland et al., 1998), identity is a means through which individuals understand and act upon their environments. To understand how Bob acted as a subject in his activity system in Lake Middle School, it was useful to focus on the identity performed (Brickhouse & Pottern, 2000) in his role as a first-year science teacher.

As has been supported in Nathan's case and will be revealed in Bob's, novice teacher identity formation is a central, dynamic force influencing the way the beginning teachers interpret classrooms and leading them to manage and shape the activity systems in which they operate (Cole & Engestrom, 1993). In this sense, the identity of the beginning science teachers and the way their identity works shapes their work within

their activity systems and structures novices' capacities to identify and use the opportunities for action that are available to them. In turn, their identities are, in turn, shaped by these opportunities.

Table 7.1: Synopsis of components of Bob's first-year activity system

Personal Teaching Identity	-Competent community member		
	-Student-Focused		
	-Reform-Minded		
Identity expected of Beginning Teachers	-Active community members of a professional community		
	-Participatory		
School	Institutional Description	Goals/Objects	Community
Lake Middle School	37% Minority	Educating lifelong learners	Empowered teachers
	63% White	Providing most effective learning opportunities	Strong sense of community of practice including parental involvement
	19% Free or Reduced Lunch/Middle class socio-economic		
	Public middle school		Valuing professional development
	High achieving A School		
	High School Capital		
Support for Beginning Teachers	Mentor Teacher		
	First-year Teacher Consular		
	Teacher Mom service		
	Student Substitute		
	Unofficial support from other teachers		
Subject	First Semester	Second Semester	
Taught/Work Load	5 8 th Grade Physical Science	5 8 th Grade Physical Science	
	Coaching Boy’s soccer team	Coaching Girl’s soccer team	
	Participating other 8 th grade team activities	Participating other 8 th grade team activities	
	Participating in school professional development activities	Participating in school professional development activities	
Classroom Context	Generative, high interaction		
	Effectively designed physical space and sufficient supplies for activities		

A close look at Bob's first-year activity system revealed that Lake Middle School's activity system generated a positive emotional energy (Olitsky, 2007) required for beginning teachers to gradually begin to participate in the work of the community and assume that work as their own. As will be discussed, this positive emotional energy was

generated through the recognition of the particular needs and expertise of novices, so that they were immediately recognized as valuable member of the wide community, able to make contributions to the community as well as in need of support from the community as they grow into their professional roles. Teachers' professional development was an explicit focus Lake Middle School, and this context allowed for official and unofficial opportunities for teachers to communicate with each other. Lave and Wenger (1991) describe that one of the prime drivers of learning in a social setting is the need to belong, and we see that full membership in the Lake Middle School professional community was available to Bob during his early days in the school. The institutional characteristics of Lake Middle School opened new venues for Bob to become and act as a full member of 8th grade team where all of the 8th grade teachers work collaboratively to provide the most effective learning experiences for their students.

In his first-year activity system, Bob pursued various different identities as he moved toward mastering essential skills and knowledge to become a competent member of Lake Middle School. Clearly, the identity he selected and performed as a teacher at Lake Middle School was that of a responsible, competent, community member. As a responsible teacher, providing the best opportunities for his students to develop necessary skills and perceive new roles as learners became central to Bob's actions. Also, his sense of being responsible also led Bob to search for alternative teaching strategies to enhance all of his students' science learning. Through his facilitator role, his well-structured classroom rules and his emphasis on reaching all of his students, Bob was able to generate a positive emotional energy within his classroom.

Echoing to Wenger's (2000) conception of a "community of practice," Bob's classroom context also facilitated learning through social interaction. In Bob's classroom, learning as a collective activity for which Bob was responsible, provided the scaffolding for his students to acquire the skills and knowledge needed for participation in the activity of the class. In such a view, his students' learning involved not only developing new knowledge but also acquiring an identity associated with that group (Olitsky, 2006).

Through a combination of positive energy, well structured classroom management, as well as activity-based collaborative learning opportunities, in a relatively short time of his first year, Bob was able to form his successful and responsible teacher

identity that cultivated opportunities for other teachers to recognize Bob's teaching success, supporting Bob's self-portrayal of competence.

Bob performed his competent, responsible teaching identity outside of the classroom context. Although he did not have any interest and experience in soccer, nor coaching in general, at the beginning of the school year the school administration encouraged Bob to coach the school's boys soccer team. Bob accepted. Although this activity required a considerable amount of time for preparation and practice, Bob successfully worked with his team and they won the district competition his first semester as coach. The following semester, he coached the girls soccer team. They took second in the district. Once again, this venue allowed others to see Bob as competent, responsible, as well as an active community member. The positive recognition this role provided for Bob allowed him to feel a profound sense of belonging to the wider Lake Middle School community.

The open aspect of his professional identity allowed Bob to seek many resources in his quest to become competent. He commonly planned with Rose, his close colleague on the 8th grade team, actively soliciting her advice when something arose that he was unable to deal with and actively supporting her when required. When students behaved in his classes in ways he could not understand or manage, his first reaction outside of the classroom was to contact their other teachers, soliciting their input. When the families of such students needed to be accessed, this was done by a collective of the students' teachers--one of which was Bob. As described in chapter 6, Bob had a high teaching self-efficacy, seeing himself as very capable, but recognizing there were areas of his practice requiring further attention. He often acted on such realizations, going to members of his school community that he saw as having greater expertise than his own.

It must be recognized that the actions required to maintain this professional identity were at times internally contradictory. Taking an active role in extracurricular activities such as coaching, organizing 8th grade trips and the Science Olympiad prevented him in some ways from fuller participation in the broader teaching community at Lake Middle. He was not available before school, as he was often setting up his classroom for the activities for the day, and after school sports required his time and attention. Because of his extra-teaching commitments, he had to make full use of his

time during the school day--thus he did not watch others teach, and he did not work to establish close relationships with the staff and members of other grade levels and departments. Bob explained "I usually don't have much of a chance to [watch other teachers]. I've got one planning period and I am here usually grading or fixing the room or getting ready to do the next lesson." (B11/17/05 P.3) Every school day, Bob came to school an hour and half before the school day started, and he spent this time for planning and preparations for the activities, and he usually left campus about 6:00. The intense time before school was needed because much of his afterschool time was taken up by soccer.

Although his successful participation in many activities served to limit some aspects of his enculturation, this participation allowed him to be seen as a competent, open, community member (echoing his identity during his undergraduate program). The performance of this identity generated positive emotions for both Bob, maintaining his willingness and enthusiasm to further develop in his role as a science teacher at Lake Middle School.

Object

Within CHAT framework, objects are essential in activity systems; their primary function in these systems is to motivate activity (Engestrom, 2001). As introduced earlier in Nathan's case, CHAT suggests that novices work to merge or blend their own objects and the institutional objects (Davydov, 1999; Engestrom, 1999; Sounders, 2006). Thus, at the center of object formation novices confront ambiguity, interpretation, and/or sense making, generating bases for potential for change and development in the wider activity system.

Indeed, description suggests that there is a critical difference between an individual's and institutional objects. However, because of Bob's purposeful selection of his first-year school environment, Bob's individual and institutional objects were very similar. Bob started his first-year activity with an explicit object that profoundly led his first-year activity system. In his perception, Bob understood that being a science teacher required him to be responsible for providing his students with the most effective science learning experiences possible. To achieve his object, Bob was critically aware of his first-

year teaching context in which he spent his first year. It was because of the similarity between these two different objects that Bob's first-year activity system did not generate essential contradictions requiring Bob to change. This similarity between his individual object and the school's object generated a profound comfort level for Bob to feel an ownership for Lake Middle School's object as means to achieve his first teaching goals.

Requirements for Effective First Year

Enactment of science education reform was Bob's primary teaching object. Bob came to take on this object as his own through his preservice teacher preparation, and his early field experiences in diverse classroom settings provided Bob with a deeper understanding of what these practices would "look like" in a diverse classroom context.

Bob indicated that he went through a dramatic change in his beliefs about teaching during this preservice period. When he first heard about inquiry-based teaching in his methods course, he thought that it was "floppy bunny college professor nonsense." (B/06/22/06 P.5) However, the more he learned about inquiry and observing utility in the realities of classroom, Bob became convinced of the utility of inquiry as a teaching approach, particularly teaching to a diverse student population.

Bob also came to an understanding of the importance of classroom management in achieving his object during his preservice experiences. But this realization became more apparent as he experienced difficulties well into his first-year teaching. Toward the end of his first year, Bob seemed to have more relaxed classroom management style where students were too comfortable to misbehave in his class. He specified:

If you have a bad first day, a bad first week, you can write off the rest of the year, because once you lose them you don't get them back. And I am fighting, losing that battle for one of my classes because somehow I lost them and I'm not gonna get them back. (B/02/27/06/ P. 2)

During the first year, Bob came to more deeply understand the role of classroom management in achieving his teaching object

Community

CHAT is a theory of human development that understands societies and their members to be mutually constitutive (Wells & Claxton, 2002). Drawn from the

trajectories of both CHAT and the situated perspective, novices acquire new information and skills through their intrinsic interest in the activity and desire to contribute as valued members of a community (Engestrom, 1999; Lave & Wenger, 1992; Wells & Claxton, 2002).

A newcomer's sense of contribution to an activity system helps them to feel a sense of belonging to the activity system, which eventually enhances the novices' willingness and helps them to maintain their willingness to participate in the activity system (Collins, 2004; Olitsky, 2005). Thus, the interaction rituals and the positive energy are recognized to mechanize the transformation of novices into members of the community

At the outset of Bob's first year activity system, it was evident that Bob's work in the community of his first-year activity system generated a positive emotional energy both within his specific classroom context and his broader first-year activity system. The purpose of this section is to explore the essential community members who played crucial roles in the activity system of Bob in Lake Middle School.

School Administration

Bob understood that the entire administration team of Lake Middle School paid particular care to supporting teaching and learning activities in the school. The primary role of this team was to ensure the effective communication among the community members and support teachers with their curricular and extracurricular activities. At the center of Bob's transformation into the school's activity system, his communication with the school administration was rare but supportive. Since the Lake Middle School's activity system empowered teachers, the school administration ensured that beginning teachers received the essential support that they needed, supported often provided by teachers and other community members. Bob had a strong sense that if he had a contradiction or problem the school administration was there to support him. For example:

When I had issues with choosing [members for] the soccer team, I went in and talked with the principal, she had an open door. I said: "Hey can I talk to you for a little bit?" She sat down with me for an entire hour and just talked to me about,

you know, sort of made me feel better about what was going on, and I got her advice on the problem I was having. (B11/17/05 P.7)

Some support came in more formal means. For instance, the school principal came to Bob's classroom to observe him. After the observation, the suggestions and advice that his principal offered worked to make Bob more comfortable with his teaching role. For Bob, some of the support offered by his school principal occurred through strong patterns of communication with her teachers and students. Likewise, the rest of the school administrators were also supportive of teachers, often ducking into teachers' classes to garner quick "snapshots" of the teaching and chatting about their ideas quickly between classes. The school administration provided and initiated professional development activities for teachers and also encouraged them to participate in other available professional development activities within and beyond the school community. It was evident that teachers, including Bob, enjoyed this encouragement provided by the school administration.

When I met with Dr. Atkins, the principal of Lake Middle School, I was expecting a middle school principal with limited time for me and my research questions. However, similar to Bob's description, my first impression about her was very positive. She was welcoming and talkative. She took particular care in considering my questions, but seemed free with her thoughts. I found that Dr. Atkins was an experienced social sciences teacher with a Ph.D. degree in educational leadership. She had been a principal at Lake Middle School for over 10 years. Within this time frame, her school had been very successful in terms of student achievement in academic and extracurricular activities.

Although science was not her major interest in teaching, her beliefs about science and science teaching were quiet pronounced. She understood that science was not solely content; rather it was a process of problem solving. And according to this conception, a strong science education was necessary for middle school level students, perhaps in part because of the scant attention some children paid to science in elementary school. In terms of the significance of science, Dr. Atkins explained that through learning science students would develop appropriate skills for problem solving along with their understanding of how things work and why they worked in daily life. She noted:

I mean I love to know how electricity works. That's like magic to me. But now do I really care? All I really wanted to do is turn on. [She laughs], My car the same way. I like the mechanical things, but I want my car work every day when I turn it on. But if it doesn't work I don't wanna be taken advantage of either. I think same thing with science. You don't wanna have somebody sticking something in the light socket because they don't know they're going to get shocked. I like science. I find it fascinating. (Dr. Atkins/04/28/06 P.4)

Her perception of science teaching addressed the necessity of students' development as being scientifically literate individuals in the society. In her perception, to help students to be scientifically literate individuals, she understood that science classes were important places to provide students with a curiosity to learn about the world.

In terms of her beliefs about first-year teaching in teacher induction, Dr. Atkins noted that the first year was the most difficult period in the teaching profession. However, in spite of the challenges, she noted that the induction period meant the beginning teachers were engaged in a constant learning period. In this regard, she highlighted that teachers should have an "induction" period for every year—that they should always be open to learning and adjusting their practice. She mused that starting each year as if their first year in teaching would motivate teachers to update their teaching knowledge and skills.

As far as specific induction experiences of beginning teachers in her school, Dr. Atkins felt that the culture of Lake Middle School was extremely supportive for beginning teacher. She explained that school administrators, school staff as well as teachers were all committed to help first-year teachers to make their transition from preservice to in-service as painless as possible.

Dr. Atkins did not see it as her role to mold or shape Bob in his first year. Rather, she saw herself and other administrators in a supportive role, ensuring through their work with other teachers that Bob had every needed avenue of support. In spite of her relatively limited involvement in Bob's first-year activity system, it was evident that Dr. Atkins was communicating with other teachers around Bob to ensure his successful first-year experiences. Based on her communication with Bob's colleagues, she was satisfied with Bob's performance during his first year teaching at Lake Middle School. Dr. Atkins

specifically indicated that Bob's rapport with his students was exceptional, and he had a strong content and pedagogical background in teaching science. She also noted that along with the support that Bob received from the other teachers (especially Rose) and because of Bob's willingness to achieve his teaching goals, he was making great gains in reaching his teaching goals.

Dr. Atkins' relatively limited communication with Bob did not signify her lack of interest in his success. Rather, at Lake Middle School, supporting novices was the work of the community. It was Dr. Atkins' role to ensure that community was functioning properly in this regard.

Teachers and Sense of Collaboration

The teachers at Lake Middle School had strong commitments toward active, student-centered teaching and learning. As far as Bob's adaptation to the activity system of Lake Middle School, the community members played a significant role in helping Bob to become a competent member of the school. The institutional structure of Lake Middle School, which mainly consisted of grade level teams and their specific interaction rituals, helped Bob feel a profound sense of belonging to the school community during his first days in the school.

Among many others, Rose played significant role in shaping Bob's first-year experiences. Rose was one of the 8th grade science teachers with a recent National Board Certification. Bob and Rose's relationship did not start as formal or assigned mentor-mentee relationship. Instead, since they were in the same grade level team, they started to cooperate as coworkers in Bob's first days in the school. Mrs. Glace, the official first-year mentor teacher, realized the promising pairing of the two, and assigned Rose as Bob's second mentor. Quickly, Rose became the most prominent and influential member of Bob's professional community, and they quickly formed a close working relationship.

According to Rose, there was a great sense of cooperation at Lake Middle School among, teachers, administrators, parents and even the custodial staff. Compared to other beginning teachers' situations at other schools, Rose noted that Bob received exceptional support and encouragement in his first year in teaching. Rose understood beginning teacher attrition to be largely due to contextual factors, and she explained that the

supportive context found Lake Middle School was in place to help young teachers overcome these problems.

Indeed, just as Bob had hoped when he selected Lake Middle for his first year, by year's end he was quite happy with the support that the school community--particularly the coworkers in 8th grade team as well as his administrators. Something he had not foreseen was Rose. By year's end, Bob realized how lucky he was to share his planning time with a successful, open, reform-minded science teacher. He understood the vital role discussions with Rose played for him. When a lesson was less than successful, he and Rose would dissect the presentation together--problem solving for the next time it was taught. They shared the location and preparation of materials. They lamented their failures with problem students and applauded one another over successes. They supported each other's professional stances. Rose was a source of insight into the workings of the school, and Bob brought his particular science expertise and array of fresh teaching ideas to the partnership. For Bob, Rose played significant role in assisting him in addressing his needs within his first-year activity system.

As far as the broader science department, Bob explained that it was "pretty strong" and "[the department] has a lot of competent teachers who like to go outside rather than opening the book and doing the section reviews. You know we're always doing projects, experiments." (B11/17/05 P.1) It was evident that the science teachers here were commonly engaged in projects and experiments. The science teaching culture supported student-centered, activity based teaching approaches, so at Lake Middle, Bob found a close match between the science department and his own teaching approach.

More than the close match pedagogically; Bob was comfortable at Lake Middle School:

When I wake up in the morning, I am still excited about coming here and seeing the kids and getting to do the lesson and stuff. So it hasn't gotten monotonous yet. And it doesn't seem like it is going to. So in that sense, I'd say better than I expected." (Bob, 14)

Indeed, soon after he started at the teaching profession, being a part of Lake Middle School community was a source of pride for Bob and thus he proudly wore his name tag when he went off-campus. He specified "I'd rather be a teacher here than

anywhere else.” (B11/17/05 P.5). His teaching position at Lake Middle quickly became part of his personal identity.

My observations affirmed that the community at Lake Middle had a commitment to improve their practices and develop their skills through in-service activities within the school. One of the most recent school-wide professional development activities was a faculty reading program in which teachers read *Handbook of Classroom Management* by Marzano et al. (2005). For this activity, the entire faculty read and discussed about the issues relevant to their teaching environment. After reading and discussing the ideas, the faculty members tried to apply what they learned into their classroom teaching, and they shared their feedback on these applications with each other during their official and unofficial meetings. The administration urged its teachers to be actively engaged in professional development activities that they thought might hold promise to enhance teachers’ daily practices.

Bob highly valued this opportunity –as he saw it as an explicit aid to support teacher’s professional development while they were actively teaching. For Bob, the reading pieces focused on organizing information, management and analogies. According to Bob, after the discussion, every faculty member tried to use analogies for their bell work activities. Bob tried it as well, in that bell work was already a standard aspect of his practice.

Students

The students at Lake Middle School were quite similar to the students Bob grew up with. Coming from similar cultures allowed Bob to build up a close rapport with his students, this provided Bob and his students with a comfort level in which teaching and learning science were the major concern, as management issues faded into the background.

Bob successfully created a well-managed classroom environment in which most of his students enjoyed the activity-based and cooperative learning experiences. Bob was able to generate positive emotional energy for his students, promoting their sense of belonging within his activity system. Through his successful interaction rituals, such as consistent emphasis on science process skills and classroom management rules, students

largely knew the behavior expected from them even if some were not as comfortable with some of the less directed aspect of their sense making. Watching his classes, it became evident that most of his students were motivated and willing to participate in classroom activities. There were few students that presented a challenge to Bob. He understood that these students had a lack of motivation and familial care and they showed discrepancy in his class through their unmotivated and disruptive behaviors. Within his teaching, he tried to encourage his unmotivated students to participate in activities since he believed that as long as they tried they would eventually be interested in learning in his class.

Bob realized that he was walking a tightrope. He wanted to motivate these less than motivated students, but not to ignore the needs of the “well behaved” students in his class. He was very cognizant of how the demands of a few could capture all his time and he actively worked to overcome that pattern.

It is often considered that students are a central factor in teacher decision making regarding inquiry (Lederman, Abel, & Akerson, 2007; Yore et al., 2007). If students are unable to successfully participate in reform-based practice, eventually teachers will reject such practices. The students at Lake Middle allowed Bob to enact reform based practice, and his work with Rose gave him the time and support to reflect on their efficacy.

Parents

In his first year at Lake Middle School, Bob was impressed with the exceptionally high parental involvement. He explained:

It is funny here, not a day goes by that I don't hear from at least one or two parents. When I was doing my internship at the high school, I heard from maybe one or two parents the entire year. (B/09/13/05 P.6)

Every morning Bob regularly checked his email to maintain his communication with parents. It was also common for parents to call Bob at school to talk about their students. Parents seemed to enjoy the easy communication with teachers at Lake Middle School. Bob came to realize that there was a considerable amount of parent involvement at Lake Middle School and parents seemed to be “on the top of what their kids are doing.” (B/09/13/05 P.6) Although Bob did sometimes feel pressured to respond to this attention, he recognized that high parental involvement was a good source of motivation

for his students. It speaks to the prevalence of student-centered, activity-based practices at Lake Middle that parents did not contact Bob about their reservations in terms of his teaching style. Clearly, the entire community of Lake Middle interacted in ways that allowed for and supported reform-based science instruction.

Division of Labor

This section describes the salient facets of division of labor in Bob's first-year activity system. First, we will explore various support sources available for Bob and a discussion of their effectiveness in helping Bob to become a competent member of Lake Middle School. In addition to support sources, we will also look at Bob's responsibilities within the notion of division of labor.

Bob's First-year Responsibilities

In his first year, Bob's primary responsibility was to teach five 8th grade physical science classes. Each day he came to school around 8:00 a.m., more than an hour before school began, to prepare for the day. In addition to this time, Bob also had a planning period for preparation.

At the center of his first-year responsibilities, it is important to note that a profound sense of cooperation between Rose and Bob was a crucial facet of Bob's first-year activity system. From his first day in teaching, Rose and Bob worked together. Their primary emphasis was on planning, including unit and lesson planning. Too, Bob and Rose continuously reflected on their daily teaching experiences to ensure the effectiveness of what they did in their classes. Indeed, sharing their experiences appeared to be an important facet of their cooperation--something directly related to their effectiveness. Based on these post discussions, they made future inferences to improve the effectiveness of their teaching.

Besides his own teaching responsibilities, Bob was also involved in the 8th grade team in which 8th grade teachers shared responsibilities in organizing activities of their grade level (i.e., school dances, trips). The teams were responsible for organizing the related grade level activities through their formal and informal staff meetings.

Besides these two responsibilities, as mentioned previously, Bob was the coach for both the boys and girl's soccer teams. While these experiences played a significant

role in helping Bob as a competent member of the wider school community, the time and effort they required severely constrained his efforts. Thus, while he became a familiar and trusted member of the faculty and his success was particularly motivating for a segment of his student population, he had little time to access the community outside of Rose and the 8th grade team.

Support for Professional Development

At the center of Bob's first-year activity system, shared responsibilities in support sources available for Bob appeared to be crucial facet of division of labor. It is important to note that Bob received a vast amount of help through official and unofficial support sources during his first year in Lake Middle School. The official help sources included the county's first-year teacher support program and also a mandatory first-year mentor teacher program. Along with these official support resources there were also some unofficial support sources provided by Lake Middle School for Bob during his first year.

First-year Teacher Program

Bob was required to participate in the District's first-year teacher program along with Nathan. Echoing Nathan, Bob described that the county's first-year teacher support program as not a meaningful source of support. He expressed "It tends to make it [the first year] harder." (B11/17/05 P.5) According to Bob, the time that he spent for the support program would have contributed more to his development as a first-year teacher if he used it for his school responsibilities.

The program included seminars on reading strategies to use in the classroom and classroom management. Like Nathan, Bob found much of this redundant. He noted:

To me it seems like, I spent the last five years in college, three of which were in the science education program, where I was taking all these content courses and all of these educational courses. And then I am sitting here having to go through the same thing again on the top of full time teaching load. It seems unnecessary.
(B11/17/05 P.5)

Bob believed that the support program should be redesigned based on the individual first-year teacher's needs and their previous preparation.

In spite of the overall ineffectiveness of this support program, both Bob and Nathan found the focus groups helpful. In focus groups, beginning teachers had opportunity to meet with all first-year middle school science teachers to share experiences relevant to teaching middle school science under the guidance of experienced science teachers. The focus groups set the stage for beginning science teachers to openly discuss and share their daily first-year experiences. Bob learned a great deal from these discussions. But overall, the District's first-year program was not successful for Bob, and it represented an investment of time and effort that he could ill-afford.

Mentoring

It is a testament to Lake Middle's effective community structure that Bob had two mentor teachers, one that was official (Ms. Glace) and one that began informally (Rose) and evolved into an official relationship once its promise was noted.

Rose

Bob perceived that mentor teachers' primary responsibility was to "show" beginning teacher "the ropes." (B/06/20/06 P.1) Because of the complex nature of the school system, there were many different tasks, procedures and requirements for beginning teachers to learn. The mentor teacher was there to guide and inform novice teachers about these regular activities. Bob believed that the most effective support was that which came from the experiences and expertise of the mentor teacher.

Rose's multiple roles as an official mentor, coworker, 8th grade team member as well as a friend played a significant role in shaping Bob's professional development in his first-year activity system. During his entire first year, Bob and Rose worked cooperatively on their daily preparations. Rose quickly became a significant part of Bob's days in school and he explained: "All the time, Rose and I are both going back and forth across the hall talking about how the lesson plans are going and what we need to change. We get here early to plan every day." (B11/17/05 P.2)

Since Rose was a critical person in Bob's first-year activity system, it is important to understand her teaching beliefs and philosophy. Rose was teaching 8th grade physical science and her classroom was located across the hallway from Bob's. Rose had been in teaching for 9 years and she spent last five years of her teaching career at Lake Middle

School. Rose's teaching philosophy echoed Bob's. She described herself as a lifelong learner who placed a priority in instilling this value in her students:

I want them to appreciate things; question things, wanna learn, get on the internet to find out information on things. You know I want them to be more interested about the world. I want then to get, you know, become lifelong learners, and not for them to grow up and think that people are gonna give them the answers to everything; you know it is just, that is a shame. (R12/16/05 P.1)

Indeed, her overall goal was to teach her students to think for themselves, question, become lifelong learners, to "go in here in the middle grades and get these kids at least interested to wanna learn more." (R12/16/05 P.1)

For Rose, the ultimate measure of her effectiveness was her students' achievements in her classroom and in high school. She did not consider her students' achievements on the state achievement test a measure of her effectiveness. Indeed, Rose did not see a significant correlation between the state achievement test and her students' performance in her classroom. Although the whole school population, including her students, continuously performed very well in the test, she explained "I don't put a lot of stock on [the achievement test] like everybody else does." (R12/16/05 P.2) That said, Rose indicated that she was not able to down play it. Since these assessments were a reality of her teaching context, she wanted her students to take them seriously and perform well in the test.

Echoing her teaching philosophy, as a role model, Rose helped Bob to mitigate the demands of the emphasis on an achievement test that usually creates contradictions for first-year teachers. Although the state standards for science appeared to be the most important facet of their planning, Rose's overall perception about the standardized achievement tests supported Bob's incoming position on this issue, allowing both of them to focus on promoting students' science learning rather than preparing them for the test.

Bob understood that Rose's teaching goals were similar to his teaching goals, and he saw that because of their similar teaching philosophies, they worked in harmony. Bob noted:

We have very similar teaching styles and philosophies. So, it was really easy to work with one another in terms of when I have an idea she thinks it is a good idea;

she has an idea, I think it is a good idea. And we were able to incorporate that into our teaching. So that our classes, our students had some sort of inter-class interaction and that really kinda made the year a little bit more fun because it added that extra element to it. (B/06/20/06 P.2)

The official nature of Rose and Bob's mentor-mentee relationship began as an effort to help them both, providing Bob with support and providing Rose with mentor hours she needed to pursuing National Board Certification. Beyond the official mentor-mentee relationship between them, Rose believed that while she was mentoring Bob, she understood "Bob is more fresh with education than I am. I haven't been in true science classes for a while. I don't know. I think we work well together, two people plan for one class." (R12/16/05 P.5)

After starting to work with Bob, Rose considerably changed her priorities in science teaching. Before Bob, the center of Rose's science teaching profoundly based on the text book and she taught "what was in the book and what is kind of cool." (R12/16/05 P.2) However, with Bob's arrival, both Rose and Bob agreed to base their science teaching priorities on the state's science standards. And then their ultimate teaching goal became the "understanding of the concepts." Thus, she wanted her students to have a real foundational understanding of the concepts.

As she was one of the graduates of the science education program where Bob also received his preservice education, the science education professors in the department had communication with Rose and gave voice to their high expectations for her. Rose was aware of the community's high expectations of her, and because of these high expectations, she tried to maintain her effectiveness in teaching science. Part of this she accomplished with her work with Bob. Rose noted "I can't let my guard down and relax. I need to stay being focused and you know set a good example." (R12/16/05 P.3) Rose believed that Bob helped her to be a better teacher.

Consequently, by a close look at their cooperation within the division of labor for Bob's first-year activity system, the sense of contribution that both Bob and Rose derived from this relationship generated essential positive emotional energy for Bob to feel a "satisfying teacher" role in his first year in teaching.

Mrs. Glace

Mrs. Glace was the official mentor who was assigned by the school administration to support Bob to understand the general regulations and the procedures of Lake Middle School. During this study Mrs. Glace worked with all of the beginning teachers in the school.

As far as her interaction with Bob, since they were both in the 8th grade team, Bob was able to communicate with Mrs. Glace more than other beginning teachers in the school. Her role and support helped Bob understand some of the administrative rules. According to Bob, the preservice education did not inform the preservice teachers about many of the general procedures and regulations and they were necessary facets of real teaching context.

Mrs. Glace was 8th grade math teacher with 18 years teaching experience and her classroom was located at the same hall where Bob's classroom was located. During this time, she mostly taught 8th grades and all level ESE, which was special education, up through high school credit algebra classes. The year I interviewed her was her 10th year at the school, and in her fifth year at Lake, she became a National Board Certified teacher. After she received her certificate, she started serving as a mentor for beginning teachers at Lake Middle School. Along with her experiences in mentoring Lake Middle School teachers, she also mentored other beginning teachers in other schools through workshops and monthly focus group meetings.

Although she officially worked for math department, she was knowledgeable about the issues with science education since math and science departments were previously combined and because of her past experiences with science teachers. Besides the regular departmental communication with her, Bob expressed:

She has been great. You know, if I ever need advice or have a problem she can usually help me out... She will drop her head in and say "How are things going?" Or we all have lunch together so we go to the planning room so we talk about certain students, so and so got in trouble in my class so watch out when they're in your class; or so and so has been struggling in my class do you know anything about that? (B11/17/05 PP.2-3)

The beginning teachers at Lake Middle School knew that whenever it was needed, Mrs. Glace was committed to help them with their problems including instructional,

administrational, as well as these teachers' problems with their students and other teachers, and for Bob "It is always nice to know that there is someone who has been where you are and is enthusiastic for helping you out." (B11/17/05 P.4)

Since Mrs. Glace was not a college of education graduate, she started the teaching profession with a limited background in teaching. Her first students were at-risk in terms of their socio-economic status and their low background in math. The contextual and personal factors impacted her first-year experiences making that year very difficult for her.

Mrs. Glace realized that without support and encouragement, it was quite possible for a beginning teacher to leave the profession. She received the necessary support from her assistant principal who was formerly a math teacher. Mrs. Glace explained "She made a big difference for me. And I think that was the reason why I didn't quit. It was because of the work she did with me." (G/05/03/06 P.1)

Based on her experiences as a beginning teacher, Mrs. Glace understood that beginning teachers were in need of intense support and encouragement to remain in the teaching profession. She explained "I like to be a part of, helping them stay in there, not giving up because the first year is so hard." (G/05/03/06 P.2) Given that the first year was the most difficult time frame in the teaching profession, Mrs. Glace encouraged new teachers so that they could stay in teaching during their first year.

It is also important to note that Bob's personal characteristics played a significant role in shaping his communication with his mentor teachers. It was evident that his open identity and receptiveness to others' suggestions made the mentor relationship particularly productive. According to Mrs. Glace, Bob had an open personality so when he needed help he did not hesitate to seek it. Mrs. Glace noted:

...that's a good quality because a lot of times people, they don't know something and they're afraid to ask and they think that they should know so that they figure it out by their own. And then they often end up doing what was maybe not the best thing because teachers have to be diplomats, you got to handle things just so with parents and with kids. And it takes a lot of politics sometimes to do the right thing... (G/05/03/06 PP.2-3)

At the outset of Bob's first-year activity system, mentoring was to be an effective support tool for his development as he mastered the necessary skills to become an effective science teacher. Because of his strong relationship and cooperation with Rose, much of Mrs. Glace's efforts were not needed. However, while Rose played a great role in supporting Bob with the unique issues with science teaching, Mrs. Glace helped Bob with official requirements such as administrative issues and also the issues specific to first year teaching portfolio.

Other Official Support

Another support that the county offered for beginning teachers was a "Teacher Moms and Pops" program, which was an optional support service. The purpose of the Moms and Pops program was to provide beginning teachers assistance in developing effective lesson, helping them with their grading and if possible the practical issues related to teaching through the contribution of the expertise of retired teachers. At the beginning of his first year, the school administration encouraged all beginning teachers to work with a in this support service. Bob, being a community member, decided to work with a retired teacher while Nathan decided not to participate. Bob's teacher "mom" visited Bob every Wednesday. Bob explained that since grading was not his favorite responsibility, he received a significant amount of help from his teacher "mom" in this area. His overall perception about this program was

...retired teachers come in and you know if I am backed up on grading she helps me grade or if I am having issues with a student she talks to me about her experiences, if I need to organize the classroom or something she can help me with that. If I need something copied, you know whatever we need they are here for. So, that is kind a cool. (B11/17/05 P.6)

In short, at the center of Bob's first-year activity system and his activity system's division of labor, it was clear that Bob's identity as an open minded community member made support programs profitable for him. Thus, the combination of his receptiveness and the abundance of support sources played significant role in helping Bob negotiate the problems and workload associated with the first year.

An Instance of Support

As far as Bob's first-year socialization within Lake Middle School context, Bob did not face any contradictions since his personal characteristics and the contextual features of his first-year activity system hindered the possible tensions that many beginning teachers experienced. The school environment was very charming for him, so that Bob came to understand that he received an efficient amount of support sources in his teaching context at the beginning of the school year. Bob explained "I have been treated very well...whenever I needed anything, either somebody in the office or one of the other teachers has been more than happy to help me out. I guess I cannot expect any more than that." (B/09/13/05 P.6)

Along with the overall supportive school context, Bob received a vast amount of attention and support within his 8th grade team. The team had their lunch together daily. During this break they talked about daily issues and their specific classroom experiences. Too, this opportunity was important for these teachers to discuss specific students and their performances in their classes.

As far as Bob's perception about the entire 8th grade team, he explained "It is always nice to know that there is someone who has been where you are and is enthusiastic for helping you out." (B, 14) The team appeared to be an important emotional and practical help source for Bob. The significance of having a strong socialization with other members became explicit when Bob had contradictions within his own teaching context. For instance, during his second semester in his first year teaching, Bob had issues with his students and the problem frustrated him. In one of his class, he wanted his students to watch a video as part of instruction. During the class he turned off the lights and had a seat right across from his students so that he could observe the classroom during the video. Despite his intention to observe his classroom during the class, Bob did not realize that three of his students behaved inappropriately. After the class one of his students came to Bob and told him that he needed to be watching some of his students more closely. At the time, he did not understand what his student meant. The following day the issues became a known school wide. Some students had spoken to parents, and some parents had contacted the principal.

Soon after, the principal contacted Bob, requesting an explanation. Because of his lack of experience to handle such situation, Bob asked Rose and Mrs. Glace about how to approach this problem. They explained to Bob that once he suspected any irregularity that he was supposed to let others know about the problem immediately. They helped him phrase his response to the principal and talked him through how to handle this issue with his students. What could have been a black mark on this reputation became a small obstacle to overcome. Thanks to their support, Bob was able to overcome this obstacle.

Rules

As a prominent facet of an activity system, CHAT framework describes that *rules* constitute an important resource for situated actions (Roth & Lee, in press) by promoting rituals that facilitate and govern the entire activity system (Engestrom, 1999, Paré & Maistre, 2006). As far as novice development in a work place, through the developmental lens of CHAT, Saunders (2006) argues that rules are knowledge resources for novices as new members of a community of practice. Thus, it is through learning of these knowledge resources that novices can develop and master necessary skills to become a competent member of that activity system. The purpose of this section is to provide a close look at Bob's first-year activity system in terms of its rules. The rules consisted of norms and expectations of Lake Middle School as well as Bob's own rules that he used in his specific teaching context.

Norms and Expectations of Lake Middle School

There were both formal and informal mechanisms to help beginning teachers to understand the norms and expectations of the school. Although the school administration did not place a specific emphasis on informing beginning teachers about the school norms and expectations, there was a detailed section explaining the norms and expectations on the school website. Because of the strong community of practice within and across the grade level team, beginning teachers were able to learn about these norms and expectations through their communication with other teachers.

In terms of the administrative expectations from first-year teachers, Dr. Atkins specified that in spite of their inexperience in teaching, the school administration held the same expectations for them as experienced teacher. She explained "Like for all teachers

that [novice teachers] will be effective with the students if they develop some kind of rapport and relationships so that they can teach the curriculum that is necessary within their discipline.” (Dr. Atkins/04/28/06 P.4)

Dr. Atkins also expected first-year teachers to start their first year with a deep background in pedagogical content and content knowledge. Even as Dr. Atkins acknowledged the need for a strong preservice education, she understood that were some facets of teaching that beginning teachers would only learn via experience. The structure of the school, special needs of students, and many other practical issues were problem areas for all beginning teachers. Dr. Atkins depended on the mentor system and collaborative nature of the teams at the school to help novices gain the knowledge they needed.

As far as specifying certain norms and regulations through his internalization of Lake Middle School activity system, Bob indicated that at the beginning of the school year, the school administration delivered a message to all beginning teachers in which they stressed that “teachers should live by a higher standard.” (B11/17/05 P.5) Bob thought that this message was suggesting that all the new teachers needed to be aware of certain facts such as dress code, social responsibilities and common sense of “how a teacher should be,” which the school administration noted in detail on the school website.

Besides, the 8th grade team members (particularly Mrs. Glace and Rose) played a crucial role in informing Bob about the “unofficial” general school rules, norms and expectations. For his transformation into becoming a competent member of the school, Bob explained that the entire hallway (which was the 8th grade team) worked together very well; all the teachers in the hallway used the same classroom procedures and rules and they informed Bob about these rules before the school year began.

Consequently, Bob understood that if there were any implicit rules about what teachers should do, his support system must have been effective because he had not encountered any of these norms and expectations as source of contradictions. It is also important to note that the strong sense of community of practice that Bob enjoyed within 8th grade team ensured the necessary help and support sources for Bob to lessen his concerns about the contradictions related to these norms rules and expectations.

In spite of his overall contentment with the school rules, Bob sometimes criticized some of them because of their ineffectiveness.

The school's "Lock out" policy was something that Bob did not envision as any positive contribution to his students' learning. It was common at Lake Middle School that the school administration announced that there would be a "lock out" in which all teachers were to send any student remaining in the hallway after the bell to the school cafeteria. The announcement was "Teacher's attention! We are now conducting a lock out. Please send students to cafeteria at this time. Thank you!"

The purpose of lock outs was to cut down on tardiness. The way the school organized this was to penalize students who were in the hallway after the bell by sending them to cafeteria for an entire period of a class. Bob's first reaction to this announcement was very negative. Bob said "I don't really like this because if the goal is to get them why keep them in cafeteria and have them miss the whole period of class?..." (B/04/03/06 P.1) He perceived that this way of enforcing timeliness was contradictory to its goal. Bob argued that the school administration should be a little bit flexible. He quietly mused: "If the goal is to have them in class, why not have them in class? And maybe take their name down and send them back to class but they keep them in cafeteria for the whole period." (B/04/03/06 P.1)

Regardless of his overall happiness with the school administration and their practices, these events of the Lake Middle School activity system generated relatively small amount of contradictions for Bob. However, Bob understood that each institution had its own unique realities that required him to be able to live with them. As opposed to Nathan, Bob never perceived himself as a change agent to inspire systemic change in his school. Rather his main concern was to provide the most effective science learning experiences for his students within the potential of his school context in spite of his opposing perceptions about some of the administrative incentives.

Other Official Rules and Regulation

Based on the county's salary policy, Bob received a fixed first-year teacher salary at Lake Middle School augmented with a teaching supplement; a salary that was relatively low compared to that of teachers in other states in the nation. Perhaps because

Bob did not have an immediate family to support, this salary did not present a particular limitation for him. Indeed, in terms of benefits and other perks, Bob was not interested in how much he earned in teaching. Rather than monetary gains, he believed “Being in a job you enjoy is sort of a perk.” (B12/02/05 P.1) For him the actual “perk” that he expected from his job was to achieve higher standards with his students.

Bob was aware that based on the student performance in the state achievement test, teachers of the higher achieving students may receive a bonus. However, Bob was skeptical about the idea of teachers’ salary based on performance, echoing Rose’s own view of this subject. Because of the bureaucratic issues embedded in federal and state level government offices, he believed that it was very difficult to provide fair assessment system for teachers based on their performance. Bob highlighted his concern with this system. According to Bob, students’ socio-economic level and many other contextual factors play a great role on students’ performance for which teacher performance is one of the determining factors among others. Consequently, he explained:

So if you do it [awarding bonuses] based on the state achievement test there are disadvantages. If you do it outside of the state achievement test, there are disadvantages. And I think nobody gets into the teaching for the money. So teachers who were in teaching for the most part want to be teachers I think. If you are teaching for money, unless you’re retired your main job and you are teaching till you die or something like that, but most teachers that are teaching for the profession. They don’t get in for the money; they get in because they enjoy it. So part of that makes me wonder why it is necessary to have performance, you know. But I also see how you should reward good teaching. (B12/02/05 P.3)

In contrast to the relatively low teacher salary, money for teaching materials did not seem to be a problem for the teachers at Lake Middle School. The 8th grade science teachers had funds for their office supplies. To supplement their laboratory expenses, the science department decided to collect a \$15.00 lab fee from their students.

We got a lot of money. Whatever we want for our lab, we usually just can go out and get it. I mean we get tax free forms; we can go to Wal-Mart and get our stuff tax free and then get reimbursed for it. (B12/02/05 P.3)

Thus it was a relatively painless thing for teachers to locate what they needed for science teaching. The 8th grade team also had a separate storage for their lab supplies in which they organized their lab equipments and supplies by units and subjects. Thus the rules surrounding classroom resources actually served to support Bob's activity based teaching approach.

It was evident that both the broader and specific rules observed in Bob's first-year activity system did not create any significant contradictions for Bob, rather they helped him to develop the necessary skills to become an effective science teacher in his specific teaching context as well a competent teacher in the entire Lake Middle School community.

Bob's Classroom Rules

As discussed earlier, Bob thought that a well-managed classroom environment allowed for teaching and learning to be the central focus for teachers and students. To structure a well managed classroom context as well as to maintain it, Bob outlined a set of classrooms rules for his students and he paid special attention to ensure that these rules were in use during his entire first year. These rules and procedures covered a variety of different activities that his students needed to go through every day in his teaching context. From entering the classroom to grading, Bob had a set of procedures that he shared with his students.

At the beginning of the year, Bob introduced his classroom procedures by saying: Procedures are a part of life. We follow procedures for driving safely, boarding an airplane, and using a telephone. Classroom procedures are important for developing a great classroom "culture" so that things run smoothly all year long. The following are our classroom procedures [Directing the students to a large poster at the front of the room] (B/Classroom Rules)

Table 7.2: Bob's Classroom Rules

Entering the classroom

- You must enter the classroom quietly, on time, and with all the necessary materials.
- Go directly to your assigned seat. Do not pass "go." Do not stop to talk to a friend. Sharpen your pencil before the bell rings if necessary.
- When in your seat, take out the necessary materials needed for class and copy your class work and homework assignments into your planner (found on the board).
- Begin your bell work quietly. The assignment will always be found on the front board.
- Sharpen your pencil and gather all your materials before the tardy bell rings. Be sure to be in your assigned seat before the bell or you will be marked tardy.

Communication

- *Always raise your hand (silently) for permission to speak or get out of your seat!!!* There should be no talking out of turn.
- Throw trash away at the end of the period.
- Please use appropriate timing if asking for permission to use the restroom. During a class discussion or note taking is not the appropriate time to use the restroom, get a drink, sharpen a pencil, or go to your locker.
- *** When I request for attention:
- Always free your hands and show eye contact. This shows attention. Do not talk when others are talking. This shows respect.
- If you have a question or comment, raise your hand, without speaking or calling Mr. Seminole's name, and wait for a response.
- If you need help at your seat, raise your hand quietly and look at me. I might ask you to come to me.

Leaving the classroom

- The bell does not dismiss you. Your behavior dismisses you.
 - Do not pack up your belongings until told to do so by Mr. Seminole.
 - Remain in your seats and quiet.
 - Mr. Seminole will dismiss you when everyone is seated, packed up, and quiet.
 - When dismissed, stand up, push your seats under the table, make sure your group table and floor is clean of all trash and clutter, and leave quietly through the hallway door.
 - If you are in my classroom last period of the day, you will be asked to place the chairs on top of the tables. Please put up all chairs!
-

Table 7.2: Continued

Attendance

- All make-up work must be turned in 2 days from the day you return from your absence.
- You must put the word “ABSENT: date of absence(s)” on the top of the make-up work, no matter what it is OR it will NOT be graded!!
- You can turn in your make-up work with the daily assignments being collected, or you can put it in the make-up work tray at the front of the room.
- It is your responsibility to get all your make-up work upon your return to school. OR, you can call a friend for the assignment and have it ready when you return. All worksheets and handouts will be found in the blue bin next to the front door of the classroom.

Working in Groups

- Mr. Seminole will almost always set up groups.
- No complaining!
- Cooperate with each other. Compete only against yourself.
- Everyone in the group should put forth the effort to complete the task.
- Use your group members to help in solving problems before you ask Mr. Seminole for help.
- When you are done
- Read a book or magazine.
- Doodle.
- Finish or start on your homework for science.
- Finish or start on your homework from another class (if you have finished all of your science work).
- Study your notes.
- Read the science textbook.

Grading papers

- Privacy is required at all times when grading other’s papers.
 - Use a green ink pen. If you do not have a green ink pen, use blue or black. Never use red ink (or a pencil if possible) to grade a peer’s paper!
 - Write “Graded by: your name” at the bottom of the paper you are grading.
 - You are only to mark X’s for incorrect answers and a final tally at the top of the paper showing how many were wrong.
-

Bob understood that these rules were essential to maintaining a classroom culture that was conducive to learning and he recognized that these rules were particularly important to him as a first-year teacher. In spite of his overall success in maintaining this well managed classroom environment, by the end of the school year Bob realized that he

had become too relaxed. He came to an understanding that in order for him to be more effective in his classroom management he needed to “keep up” and live by these classroom rules constantly during the entire school year. In his future teaching he planned to follow up his classroom rules until the end of the school year.

As far as his overall classroom management, Bob enjoyed an active class; he did not like “quiet classrooms”. Therefore, each of his classes had a moderate level of noise and activity. Bob seemed to be fairly comfortable with allowing jokes, speaking with his students and letting his students communicate with each other. Indeed, it was evident that his comfort level with their activities allowed his students to feel a sense of belonging in his classroom. Indeed, many of them stopped by to chat between classes, to bring by their report cards to show off, to query about the next day’s activities.

It is also important to note that Bob’s classroom management strategies varied between classes. The level of his tolerance of chaos was very limited in one period, whereas in another class he was more flexible and tolerant of his students. He explained that classroom management was something that needed to be adjusted constantly dependent on the situation and time. Because of the relaxed nature of his classroom management at the end of the school year, Bob understood that future students might think of him as relatively tolerant and relaxed. However, Bob noted that this was one of the facets of his teaching that he felt compelled to address at the beginning of the next year.

Mediating Artifacts

As another central component of an activity system, mediating artifacts that embody the accumulated history of human ingenuity and creativity shape the novices’ understanding of and actions in an activity system (Paré & Maistre, 2006; Roth & Lee, in press). As newcomers engage in work with colleagues, as sources of contradictions and innovation demanding actions, development, and negotiation, tools can aid and generate expansive learning opportunities for novices (Engestrom, 2001; Paré & Maistre, 2006). The purpose of this section is to describe Bob’s first-year activity system in terms of its essential mediating artifacts and how they shaped his first-year experiences in teaching.

Classroom Context

Bob recognized that the classroom environment heavily influenced and shaped how he taught. Because of the way the classroom was designed, Bob called his teaching “mobile teaching” in which there was no official structure to regulate teacher-student and student-student interaction in his teaching context. (B/06/20/06 P.3) Rather, Bob’s classroom was designed to enhance interaction between him and students and among the students.

During his first year at Lake Middle School Bob taught 5 sections of 8th grade physical science and he had one planning period. His teaching load was equal to that of all the other teachers at Lake Middle School. Within each class he had approximately 27-30 students and the student demographics resembled the school’s general student population. During his first semester at Lake Middle School, the school administration hired a new science teacher, and his class sizes were reduced, going from 30 to 27 students in each.

The first impression that one would get from his classroom context would be the considerably large space with a charming environment. In terms of his classroom’s physical features, resources were not rich within the classroom. There was no sink and any other major science laboratory equipment. However, being a physical science teacher, Bob indicated that some of the tools, which were fundamental part of most science classrooms, were not necessary for his teaching. Indeed, it was evident that the classroom met Bob’s needs. Although they were not located at his classroom, the necessary lab equipment was stored in a room which all the eighth grade science teachers used. Laboratory and office supplies were plentiful, so materials were not a hinderance to Bob’s activity-based teaching approach. Likewise there were enough textbooks for the students, although this was a resource that was only occasionally used in Bob’s teaching.

The classroom was the combination of two same size classrooms and the space was adequate for the students and the chairs. The arrangement of the desks aimed to facilitate the interactions between teacher and students and among the students. For seating Bob grouped the students based on his students’ personalities. There were four tables and approximately five students were grouped in each table.

The classroom had two large whiteboards. The main whiteboard located at the front side of the classroom seemed to be the main board, where Bob posted daily updates and announcements on this board. The second whiteboard was located at the opposite side of the classroom, and this board used for problem solving and communication of students' ideas. In terms of the technology within Bob's class, other than Bob's own computer there was no other computer in his class. The class had one overhead projector and two televisions. One of the televisions was for instructional use and other one was for the daily announcements.

Bob also decorated his classroom with posters, drawings of his students, several comics and football posters. Upon entering the classroom, the first thing that one would recognize in his classroom was Bob's emphasis on Nature of Science. From the beginning of his teaching experience until the end, Bob focused on Science Process Skills, which he seemed to be particularly proud of, given his university methods courses. Through these posters, Bob worked to highlight these skills. At the beginning of the school year, Rose gave him several posters and each of them represented one specific facets of science learning. These were mystery, questions, possibility, endeavor, serendipity, and knowledge. These also adorned his walls.

Thus, Bob's classroom did not seem to be a "state of art," but it was a fairly well equipped classroom to facilitate learning experiences. His motto that he emphasized as a part of his classroom management was "Always Respectful, Responsible and Safe." He often reminded his students to behave according to this motto and Bob made a poster about this and placed on the top of the main board.

Actually, at the beginning of the school year, Bob was not happy with his classroom structure. Because of his experiences in his early school years, Bob envisioned that classroom with regularly placed desks was the most conducive context in which to teach science. He was disappointed when he first saw that his class had no desks but instead was equipped with tables placed irregularly around the classroom. After couple of weeks, Bob realized that his current classroom set up was actually very useful. He noticed that as opposed to desks, tables played role in inspiring students for group work.

Similar to the tables, Bob was also disappointed when the school administration did not provide a podium. Before he started teaching, he always envisioned teaching from

behind this podium. Quickly, however, Bob realized that he did not stand up in front of the classroom to lecture. He always walked around the class and interacted with his students. In addition to that, Bob was quite satisfied with the abundant board space in his classroom. There were a few students who enjoyed drawing or writing their ideas on the board.

While Bob had a high teaching self-efficacy, he was dissatisfied with his organization skills as a first-year teacher. Bob explained “I still struggle with keeping stuff organized as far as my papers, you know, taking attendance and knowing really what is going on.” (B/04/03/06 P.4) Bob noted that during his school years, he was a disorganized student. On the other hand, constant observation in his teaching context revealed that he became a more organized as the year progressed. He started to use cabinets and organizers for homework assignments, test and lesson plans.

Curriculum and Achievement Test and Standards

The curriculum Bob followed was influenced by the state standards and the state achievement test. However, during his first year Bob was confident making changes and adding more subjects to his regular curriculum-- as long as he covered the standards..

It was evident that Bob liked this freedom of deciding what was important for his students and how to teach those topics. However, he was frustrated with the news that the county planned to change the entire science curriculum to integrated science the following year. According to this change, the science curriculum would become an integrated curriculum where the change would require science teachers to teach combination of different science subjects including life science and physical science. This change would demand Bob to teach life science. Bob complained:

To me it makes it less of a profession, than more of a job. I think the way we have it now, it makes you take ownership of your profession. I mean it makes you a professional to decide ‘here is the best way to cover this. We’ll spend this much time on this.’ You know making decisions versus ‘do it that way’. [This curriculum change] seems like cutting out the decisions. And if you’re doing that then why not have a robot up here teaching. A robot can say ‘Turn your page to 20 and do the section review.’ (B11/17/05 PP.7-8)

Because of this change, Bob indicated that he would be teaching some life science including genetics and several controversial issues. If he had to teach controversial issues such as evolution, and natural selection, he noted that he would need to spend more time on Nature of Science unit at the beginning of the school year. Bob explained that students needed to have a broad understanding of Nature of Science in terms of “more scientific, less scientific.” (B/04/03/06 P.8) particularly if they were grappling with ideas that are counter to their belief systems.

Bob was very contented with the current curriculum policy at Lake Middle School, and for him the current situation was “just right” and it allowed teachers to decide what was important and how to teach those important topics. He explained “I don’t feel constrained. I think if I am teaching physical science, then those are the things I want to talk about any way.” (B11/17/05 P.8)

In terms of the alignment of his teaching with the state standards and the achievement test, Bob did not see test preparation as the focus of his teaching. The state standards were important part of his teaching since they specified the minimum knowledge that his students need to learn. But it was also evident that the achievement test was not quite influential to his teaching. For Bob the achievement tests were part of the school system; his primary responsibility as a physical science teacher was to teach his students what they need to know. Therefore, the state achievement test was not an influential factor of his science teaching. He and Rose agreed that if they cover and teach standards effectively, then the achievement test will be taken care of.

Lesson Plans

Planning was one of the major foci for the Bob and Rose collaboration. They paid special attention to planning their daily activities and lessons. Their lesson plans illustrated a combination of Bob’s creativity in terms of finding appropriate activities and Rose’s expertise in terms of facilitating the activity. Because of their cooperation, Bob did not think that he needed to have formal lesson plans for each day but instead went into a classroom with a plan that outlined major components of the activity.

On the other hand, lesson planning was the only concern that Dr. Atkins had of Bob. In one of her visits to Bob’s classroom, Dr. Atkins realized that Bob did not have a

formal lesson plans. She seemed very concerned about this issue, and she brought up this to Bob and asked him to plan his lessons regularly. To best guide his planning, she also provided Bob with a lesson plan, which had detailed description of the lesson that Bob would teach. Within the lesson plan format, Dr. Atkins especially emphasized the importance of the use of time and the objectives and activities of the lesson as well as assessment for the lesson.

In terms of this planning issue, Dr. Atkins assumed that Bob's lack of interest in planning was the result of his cooperation with Rose, who was an experienced successful science teacher. She indicated that Rose might not need to have a detailed plan in the current period of her teaching. However, she indicated that Rose also had a detailed lesson plans at the beginning of her teaching career and today she might only need to have something very brief as a plan and then she would be able to expand that outline with her expertise during her teaching. Thus, according to Dr. Atkins, Bob did not have this luxury in his first year in teaching and Bob needed to have detailed lesson plans in order to teach effectively. As opposed to his principal's emphasis on his planning, Bob indicated that most of the other teachers at Lake Middle School did not formally "plan". When he asked other teachers about the requirements for planning, they suggested that he should write down his plans in a calendar, suggesting a modest notion of lesson planning.

Bob explained:

To me [formal lesson planning] is so time consuming looking up each standard and try to figure out which standard fit in each lesson. You know some lessons are five or six standards some of them maybe one. And you have to sit there and pick out which ones. It's not something that I wanted to spend my time doing.

(B/06/22/06 P.1)

However, due to his principal's requirement, Bob prepared daily lesson plans throughout the end of the semester and he turned them to his principal when the semester ended. The other 8th grade teachers turned a copy of their calendars to the school administration.

Summary

In understanding Bob's learning and development in his first-year activity system it became clear that Bob's personal history and his personal characteristics played significant role in shaping his first-year experiences. Through the lens of CHAT and its theoretical trajectories related to novice learning, Bob's first-year activity system provided an account of the crucial interplay between contextual and individual aspects of this system. From the viewpoint of activity theory, collaborative learning in the team setting can be analyzed as object formation (Engeström, 1999). As far as Bob's first-year activity system and his development, Bob internalized his activity system and sought resolutions for the contradictions through his active participation in Lake Middle School's activity system. This collaboration generated collaborative relations of workplace members toward systemic change in activities as well as venues for Bob to develop (Engeström et al., 1995).

It became evident that Bob's personal characteristics and his lived experiences generated prominent resources for his successful transformation to the teaching profession. At the center of Bob's activity system, Bob's disposition and his identity played a crucial role in orientating Bob towards taking advantage of the learning opportunities available for him in Lake Middle School. According to Bloomer and Hodkinson (2000) different learners perceive the same opportunities differently and react towards them differently because of their differing dispositions. Indeed, the very nature of any opportunities the workplace may offer for learning depends partly upon those dispositions. Bob was disposed to learn from others in his community, thus he took advantage of the many opportunities provided to him.

Within his classroom context, through facilitating effective interaction rituals including his effective classroom management rules, his emphasis on NOS, science process skills, and cooperative learning Bob generated a sense of community of practice in his classroom. These interaction rituals helped his students to develop necessary skills and knowledge essential for inquiry-based science learning. Indeed, at varying levels each of his classes had a level of positive emotional energy motivating students to participate in activities within his student-centered activity system. In addition to his

students, this emotional energy to achieve high standards also enhanced Bob's willingness to become an effective science teacher.

CHAPTER 8

CROSS CASE ANALYSIS, DISCUSSION AND IMPLICATIONS

To this point, I have presented the cases of two reform-minded science teachers during their induction year. Although much can be learned as we look within each of these very different individuals working in their different schools, if these cases are to be informative to others, it is important to look across the cases to search for patterns that are useful to understand the changes seen. Thus, this chapter includes a cross-cases analysis, the discussion of the findings of this analysis, and implications that can be drawn from this research.

Cross Case Analysis

In this section I present the meanings I derived as I looked across Nathan's and Bob's cases, and I present the particularly salient themes that emerged from the comparison.

Understanding the Subject

The central actor in any activity system is the subject. Although the "metaview" afforded via CHAT allows for an understanding of the interactions of this subject as just one facet of a much broader activity system, in order to understand science teachers and their changes using the knowledge from the science education community, it becomes necessary to focus much more closely on this subject.

Teacher Beliefs and Lived Experiences

Supporting the vast array of research that has been conducted, I found that at the beginning of the school year our two beginning teachers held a number of interrelated

beliefs about science and science teaching and learning including: (a) beliefs about the nature of science; (b) beliefs about science education reform along with their views about requirements for effective implementations of science education reform; (c) ideas of what constitutes effective science teaching; and (d) perceptions of how individual learn science. A growing body of research suggests that teachers' lived experiences shape these perceptions of teaching and learning (Smith, 2005; Weick, 1995). Because of this, when one discusses teacher beliefs, it is important to look closely at the origins of those beliefs.

Although each of these types of beliefs influenced these teachers' practices to some degree, the strength of this influence varied. This variance can be attributed to two primary factors: (1) the teachers' depth of commitment attached to the belief, and (2) the compatibility of the context to the belief. The teacher's deeply held beliefs--those that were closely tied to the teacher's own experiences as a science learner--had a greater influence in their first-year activity system than more superficially held beliefs (Smith, 2002).

Beliefs about teaching and learning. Although these teachers' beliefs influenced their first year experience to a critical extent, it became evident that contextual factors also played a significant role in reshaping these teacher's beliefs mindful of science education reform. Thus, the research further supports that the relationship between belief and context can be a recursive one--context influencing belief and belief influencing context (Smith & Southerland, 2007; Yore et al., 2007). Through the lens of CHAT, this reciprocal relationship between context and beliefs became evident as these novices faced contradictions or coherences within their first-year activity system. As one looks across the two cases, a different pattern of change for these primary beliefs emerged: While Bob's beliefs remained constant, Nathan's beliefs changed significantly over the course of his first year in teaching. To better understand the anatomy of this difference, it was necessary to look at these teachers' beliefs historically (Smith, 2005).

Both of these teachers had similar experiences during their formal school years. They both mainly learned science by traditional teaching, in which they perceived their teachers' role was to deliver science content through lectures. Indeed, reform-based science teaching and learning did not exist in their repertoire before they started their teacher education. However, after their first exposure to science education reform, their

level of receptiveness varied in a very critical way. Nathan (perhaps because of his identity, as will be discussed in a later section) quickly embraced these nontraditional ideas about teaching and learning, while Bob was much more slow and deliberate in his acceptance of the reforms.

During student teaching, Bob came to realize the extent of what he learned during his methods course in terms of inquiry-based science teaching. Bob was able to observe inquiry-based teaching style as an effective teaching approach in his cooperating teacher's classroom. His understanding of inquiry was closely tied to his own experiences as a learner in which enjoying science allowed for a cascade of science learning. Thus, Bob "took up" these messages about inquiry as they allowed him teach science in ways that resonated with his own successful science learning experiences.

In contrast, Nathan spent his student teaching in a relatively lecture oriented classroom--where he focused on strengthening his communication skills and student rapport. This situation allowed Nathan to continue to view the reforms as non-traditional, as something outside of the typical system. Too, this lecture orientation failed to challenge Nathan's early successful science learning experiences in which a knowledgeable teacher presents science in a way that inspires learners. Both Nathan and Bob left their preservice teacher education with a goal of implementing science education reform suggestions through inquiry-based science teaching, but their acceptance of this goal had very different origins for each of them.

Beliefs about science. Consistent with their reform-based preservice education, Nathan and Bob understood science as a process of asking questions about natural phenomenon. As they entered their first year of teaching they both recognized that inquiry-based science teaching was the most effective way to teach science. Both of these teachers also believed that the primary roles of a science teacher were to equip his/her students with essential scientific process skills and to facilitate learning environment where students construct their own conclusions about natural phenomenon.

Beliefs about science education reform. During the early period in their first year of teaching, Nathan and Bob successfully implemented many of the suggestions of science education reform in their NOS units, with slight but meaningful differences in their actual classroom practices. However, after these NOS units (the groundwork for

which was laid during the methods courses), their teaching practices exhibited significant differences. While Bob was able to consistently act on his teaching beliefs via the use of inquiry-based activities, Nathan's teaching did not go beyond lecturing, augmented occasionally with verification laboratory activities. Along with the difference between these teachers' practices, the beliefs also underwent gradual changes; by years' end, their beliefs were starkly different.

Bob constantly sought opportunities to facilitate various ways to enhance his students' science learning, echoing one of his own high school teacher's efforts. If one would glimpse into his classroom on a given day, one could see his students working in groups, struggling with questions, deciding how to proceed with answering the questions, and deciding what counts as evidence for the questions. During his first semester in teaching, Bob constantly examined the effectiveness of inquiry-based teaching; he left his first year teaching believing that inquiry was the most effective way to teach science.

However, Nathan's beliefs about science education reform and its implications for practice appeared to be a contradiction within Nathan's first-year teaching context, perhaps accounting in part for his lack of reform minded practice. After his NOS units, in relatively short order, Nathan abandoned his attempts to facilitate inquiry-based activities and he heavily relied on lecturing to convey content. He argued that this shift was due to the extraordinary contextual barriers he faced, primarily including the cognitive and skill levels of his students and his limited content knowledge as he was teaching out of field. Nathan argued that he need to provide the structure for his student and he was forced to cover content--this assertions being based on and his beliefs about what his students needed within the context of accountability. As a glimpse of his teaching, within his classroom, his students were listening to Nathan speak and taking notes. Quickly, his heavily lecture-oriented teaching resulted in lack of student interest, spiraling to a crisis of management in his classes. In his rare use of laboratory activates and demonstrations, Nathan became more convinced that his students were not capable of learning in laboratory, and he switched back to lecture notes and worksheets to provide structure his students needed. What makes this argument lack conviction is that his more "upper" level class, astronomy, largely reflected these same teaching practices. It must be noted; however, in his approach to Astronomy one can discern echoes of Nathan's attempts to

recreate his own profound learning experiences, as he attempted to lead his students through some of the “big ideas” in physics (i.e., Big Bang, String Theory).

In addition to the contradictions embedded in Nathan’s first-year activity system, it is important to recognize that Nathan himself did not experience the success of inquiry in his teaching, so that his beliefs about these practices did not extend beyond the superficial level. It is not surprising, then, that during a relatively short time into his first year that these beliefs underwent a dramatic shift, accompanied by much more traditional teaching practice. Nathan left his first year of teaching with major questions about the utility of reform minded science practices and even began to question the salience of the goals of the reforms.

Summarizing the change in beliefs. I argue that contextual factors interacted with these novice teachers’ beliefs, providing either contradictions or coherences. Based on the nature of this interaction, while Bob further developed his beliefs about science teaching and learning through his enactment of them, Nathan’s beliefs changed dramatically and this change dramatically influenced his practices during his first year in teaching.

Teaching Self-Efficacy and Outcome Expectancy

During their induction year, it became evident that Nathan and Bob’s overall self-efficacy beliefs played significant a role in shaping their approaches to reform-minded science instruction. The findings of this research confirm Bandura’s (1977) assertion that teachers’ successful teaching performance, explicit experience, verbal persuasion and emotional arousal contribute to and are shaped by their self-efficacies. As suggested by other scholars (e.g. Allinder, 1995; Haney, Lumpe & Czerniak, 2002), I found that teachers’ self-efficacy beliefs exhibited a vast amount of influence on their teaching practices. A detailed examination of the changes in self-efficacy beliefs suggests that personal teaching efficacy appeared to be a crucial determining factor for these novices’ enactment of science education reform. Indeed, I have found self-efficacy to be a useful benchmark for monitoring change in teachers’ first year teaching practices. That said, perhaps the most notable of the changes in the self-efficacy related constructs was seen in Bob and Nathan’s outcome expectancies.

Changes in teaching self-efficacy. At the outset of their first year of teaching, Nathan and Bob illustrated relatively high self-efficacy beliefs. They left their teacher preparation programs believing that they had the necessary content and pedagogical knowledge to teach science effectively for all of their students. They both held high hopes for the students in their classroom. Indeed, Nathan entered his first year believing that a teacher's effectiveness was the most influential factor for students' learning. Bob held a similar view, although he was not as single-minded in this notion as Nathan.

Although both teachers started their first year with a high self-efficacy, Nathan and Bob illustrated different patterns of change. During his first year, Nathan's personal science teaching efficacy diminished gradually. Much of this diminished teaching self-efficacy was due to his lack of content knowledge for Earth Science. It was also evident that his lack of content knowledge not only influenced Nathan's personal self-efficacy beliefs, it also played significant role in Nathan's willingness to implement reform-based science teaching practices. Once he understood his lack of content knowledge in Earth Science, he more heavily relied on a didactic, lecture-based teaching style. It is important to note that Nathan did not react to this contradiction by attempting to improve his content knowledge in Earth Science or to access teachers on his campus with more expertise in this field. Instead, he opted to teach in ways that were less challenging to his content knowledge.

In addition to his lack of content knowledge in Earth Science, his students' lack of motivation in school also appeared another significant contextual barrier that caused a lowering of Nathan's personal science teaching efficacy. Looking back over the year, he understood that he had the essential theoretical and practical knowledge and skills to provide effective learning experiences for diverse student populations, Nathan came to believe that it was impossible for him to teach science to his "general" students, something he saw caused by their relatively low cognitive levels, limited motivation, and lack of interest in science.

In contrast, Bob continually held high self-efficacy beliefs during his first year in spite of minor adjustments specific to his teaching context. He thought himself a capable science teacher, and, by and large, the results of his teaching served to support this belief.

This high self-efficacy allowed him to continue to “fine-tune” his approach as he noticed occasions when his teaching failed to allow students to meet his expectations.

At the end of their first year of teaching, both teachers left their first year teaching with high personal science teaching efficacy. Indeed, Nathan had reclaimed his high self-efficacy beliefs at year’s end. Because of his recognition of the severe contradictions in his activity system, by year’s end, he came to recognize that despite his ineffective first year teaching experiences, he was still an effective science teacher who held a profound enthusiasm for teaching science, he felt that he simply needed the proper context to employ his skills.

Changes in outcome expectancy. As discussed by others (e.g., Haney, Lumpe & Czerniak, 2002; Riggs & Enochs, 1990) the results of this research also underscored that teacher’s outcome expectancies played a significant role in shaping their teaching practice. Both Nathan and Bob’s first-year activity systems caused a significant change in these teachers’ outcome expectancies. Because of their naïve perceptions about the teaching profession before entering their first year, both Nathan and Bob understood a teacher’s effectiveness as the most influential factor determining student learning in science classes. They both shared the belief that students’ underachievement in science classes was a result of teacher’s ineffective science teaching practices. However, by the midterm of their first year, Nathan and Bob realized that the success of a learning experiences were dependent on a variety of factors, with teacher effectiveness being one of them. However, their understanding of the degree of a teacher’s influence varied.

Nathan came to believe that there were many factors that had a significant role in shaping students’ achievement in science classes. For Nathan, these factors were largely contextually dependent. In terms of his first year teaching activity system, Nathan identified that lack of parent involvement, lack of student motivation and interest as well as an unsupportive school environment hindered his students’ science achievement. He believed that the combination of these various different factors created perpetually low expectations of and in students, causing students to put less effort into their schooling. Nathan left his first year with a perception that a teacher’s efforts had a relatively small influence on students’ science learning.

Bob continued to believe that teachers played the most crucial role in students' achievement in science classes. But Bob also came to understand that there were other factors that also served to influence students' science learning. As he came to know and focus on the needs of some of his traditionally low achieving students, Bob understood that his typical science teaching practices were not adequately helping those students who lacked strong parental support. Instead of seeing them as "lost causes" he worked to hone his activity-based approach and took particular care to form a cooperative learning environment in his classroom. Bob, ever the community member, left his first year with an understanding that collaboration between parents and teachers was essential to help these students learn science.

Pedagogical Discontentment

Pedagogical discontentment is a relatively new construct in the field of science education reform literature (Sowell et al., 2006). This construct was devised to better understand teachers' abilities to "take up" messages of reform. Critical reflection on the utility of one's current teaching practices allows for a sense of dissatisfaction with the match between one's current teaching methods and goal. This sense of discontentment with one's current teaching practices --and so the critical reflection that precedes it-- is critical to the internalization of the messages of reform. Smith (2002) and Feldman (2000) suggest that if teachers are not discontented with their current teaching, they have little motivation to engage in ideas of reform and have little investment in making reform "work." However, if a teacher has some sense of discontentment with her current practices or knowledge, then she is much more open to changing and revising these practices.

Drawing upon the findings of Bandura (1997) and Gess-Newsome et al. (2003), recently, Sowell et al. (2006) suggest that a teacher with a combination of pedagogical discontentment and high self-efficacy may be more receptive to reform initiatives within professional development. I argue that this same lens can be employed to understand how novice teachers hone their teaching practices within a broader activity system. Sowell et al. (2006) defined five essential facets of science teaching to monitor science teachers'

pedagogical discontentment. The changes seen in each of these facets of pedagogical discontentment for the two teachers are shown in **Table 8.1**.

Table 8.1: A summary of degree of changes in the teachers' pedagogical discontentments.

	Bob	Nathan
Teaching Inquiry-Based Science	Profound	none
Teaching Across All Student Ability-Levels	Profound	none
Resolving Depth vs. Breadth Content Issues	Moderate	none
Assessing Student Learning	None	none
Teachers' Level of Science Content Knowledge	Moderate	none

Teaching inquiry-based science. One area in which Bob experienced pedagogical discontentment was his ability to allow his students to search for answers to their questions. Once he realized he was “stepping in” to explain things for his students (often times in ways too sophisticated for them), he moved toward the inclusion of provocative questions for his students, supporting their pursuit of answers through activities rather than answering their questions. Nathan, in contrast, experienced no discontentment with his abilities to teach through inquiry because his overwhelming emphasis on contextual discontentment limited his use of inquiry. He failed to experience pedagogical discontentment in this area because he understood that it was the context that posed a barrier to inquiry, not his own abilities.

Teaching across all student ability levels. Later in the year, Bob came to recognize that his teaching practices were not supporting students from a variety of ability levels. After confronting his discontentment, Bob actively searched for alternative ways to reach all a wide range of students. In Nathan's case, in spite of his teaching practices being ineffective in teaching a wide range of students, he again understood this

as his students' lack of ability and motivation, thus he perceived his ineffectiveness not in pedagogical terms but contextual ones.

Resolving depth vs. breadth content issues. During the second semester Bob realized that his personal teaching goals often overestimated his students' knowledge and abilities. He understood this to happen because of his lack of experience in teaching Middle School physical science. Although his realization of this discontentment did not generate him to take immediate action to address this contradiction, it played significant role in shaping his future teaching. He spent much of the summer following his first year planning with Rose in ways that would better take in account his students' cognitive levels. As far as Nathan's case, because of his lack of content knowledge in Earth Science, Nathan understood that his teaching approach often precluded his students' deeper connections with real life context. However, once again for Nathan, this was a contextual barrier that required a change of context, but not a change in the teacher's knowledge or skill.

Assessing student learning. Based on his use of multiple assessment tools (and copious support to help him manage these assessments) Bob was able to build a profound understanding of the effectiveness of his teaching as he focused on his students' learning. Thus, he did not experience any pedagogical discontentment in terms of assessment during his first year in teaching. Nathan mainly relied on traditional assessment tools, but given the overwhelming nature of his context, he was not often able to focus on deriving meaning from these assessments in terms of his practice. Similarly, he did not problematize the manner in which he practiced or made sense of student assessment.

Teacher's level of science content knowledge. A combination of his strong background in physics and his early intention to become a high school level physics teacher sometimes led Bob to use advanced level of physics terminology in his first year teaching. Based on his students' reaction to this practice, this became a source of pedagogical discontentment for Bob. He responded by moving to the use of more activities and student generated discussion, ensuring that the discussion level was appropriate. He also used this habit as a source of humor in his classroom, so that students were comfortable serving as immediate (and comical) monitors of the level of his explanations. On the other hand, Nathan's level of earth science content knowledge

was terribly limited. However, Nathan again understood his lack of content knowledge as contextual issue as, and thus not something to be addressed individually. Given his lack of attribution of this problem as his own responsibility, Nathan's failed to externalize a resolution for this contradiction.

Identity

The preceding two categories (self-efficacy, pedagogical discontentment) were drawn from the literature and serve as a lens through to understand the changes in the science teachers during their first year teaching. They provided part of the picture, but their use alone was unsatisfying, particularly as I tried and failed to understand the struggles Nathan was experiencing. His profound emotional turmoil, the changing degree of investment, the seemingly little externalization in the face of such disfunction could not be addressed adequately through the theoretical lenses I brought into the research. Thus, Nathan's case led me to search for an additional construct, an additional piece of the puzzle for understanding the subject in a first year teaching activity system, that of identity.

According to Giddens's (1991) definition, identity is a means through which individuals understand and act upon their environments. Kozoll and Osborne (2003) describe **identity** as "a way of being in the world, a layering of events and interpretations informing one another and produced from our participation in communal practices" (p. 158). It is the way one participates in the world and how others react to that participation (Brickhouse & Potter, 2001). Within the situated learning framework, identities are understood to be the products of ongoing interactions. Individuals tend to form multiple identities because they interact in multiple social and cultural settings each with multiple goals (Wenger, 2000). So, we must recognize that identities are not final constructs but always "works in progress" (Olitsky, 2006, p. 2): works that are effortful, that must be performed, and that must be supported through their actions (Brickhouse & Potter, 2001). That said, even though they are fluid, identities are not easily "given up" or "taken on"--as they reflect fundamentally how we work to be perceived in a particular group.

In the CHAT framework, within a community of practices, individuals form their identities through their internalization and externalization of an activity system with the

goal of becoming a competent member of that activity system (Engeström, 1999). A blend of theoretical trajectories of activity theory and situated learning frameworks, this study illustrated two powerful but sometimes contradictory identities for any one teacher, their teaching identity and their institutional identity.

Teaching Identity. Nathan's teaching identity was that "champion of the entire student/passionate rebel/competent and self-sufficient science teacher." For much of his academic career, this identity served him well. In this university teaching preparation, he was a "golden son," hardworking, articulate, critical, quick to embrace new ideas and convincingly denouncing current practices and conditions. Indeed, this identity "fit" very well in a reform-based teacher education program, and Nathan was used to and sought the "perks" of this privileged status--professors opening doors for long philosophical talks, being given "room" to voice his opinions in methods classes, high marks on his critical papers, being urged to engage in graduate coursework. His identity fit well with this environment.

This identity was in part responsible for his selection of Kent High for his first year teaching. Kent High was considered to be a difficult, low performing school-- he was a competent teacher and a student champion. He saw little of a support structure in the science department--he was competent and self-sufficient. His cooperating teacher at this school had very strict classroom discipline--his rebellious identity caused him to be a champion of the "entire" student, working to become their friend as a way to help them gain entry into the academic world. This complex identity did not serve Nathan well in his work at Kent High and an early and emotional conflict with the school administration quickly changed his goal of becoming a competent member of a reformed teaching community in this school to simply surviving the year. Nathan felt that the school administration, through their strict rules and control-oriented leadership, to be abusive of teachers (Blase & Blase, 2004).

Bob's teaching identity was that of a competent, thorough, but open member of the teaching community. Like Nathan, this identity served Bob well in his university years. His critical evaluation of new teaching philosophies were in stark contrast to Nathan's quick adoption of them, but Bob's thoroughness in evaluating new ideas was rewarded in his class discussions and writings. His competence was rewarded by a

recommendation to teach in a high-needs science remediation program in a local school--allowing him both employment and further science teaching experiences. His teachers and other students looked on Bob as a source of aid, asking Bob to help puzzle through problems with design of a lesson or applications of physical science concepts.

Like Nathan, Bob's identity was reflected in his choice of employment. Lake Middle School was known for the collaborative nature of the science faculty and the joint planning structure. The school was largely successful in terms of statewide testing, but there were students in the school that required particular care, and there was a network in place to support teachers in giving this care. At this school, Bob could be one of many caring, thoughtful, competent professionals working to help students learn.

Institutional Identity. Enydey et al. (2006) describes that being a beginning teacher implies certain norms and expectations of activity for those in the teacher role. The culture of a school supports and embraces and expects some kinds of behaviors from novice teachers and negates others.

In Kent High, the institutional identity new teachers were to assume was that of conforming novices that acted in ways that supported school policies. There was a clear mismatch between Nathan's rebellious teacher identity and the identity members of his organization expected him to adopt. This contradiction was most starkly portrayed by Nathan's vocal suggestions in one of the opening faculty meetings of the year in which he questioned test preparation strategies all teachers were to perform. Publicly (via comments at the meeting) and privately (via a conference with the vice principal), the administration quickly reminded him that Nathan was not being "forced" to work at Kent, something Nathan perceived as a direct threat to his future employment. The administrators expected conformation from novices, not critical, passionate insight.

With this episode, Nathan quickly saw that his insight, his rebelliousness, his ability were not embraced or accepted in his community of practice, thus, he quickly changed his goal of becoming a competent member of this activity system that he had hoped to reform. Instead, he withdrew, shifting his goal of becoming a member to simply "surviving" the first year. This withdrawal was also supported by the self-sufficient, individualistic aspects of his identity--early on he had rebuffed offers of aid from this

department and this aid was seldom offered again. He was largely left alone to “get through” the year.

In contrast, from Bob’s first day at Lake Middle School, the larger school community viewed Bob as an already competent member of the school community, one who held the necessary skills and knowledge to teach, but who was in need of constant support. Indeed, his 8th grade colleague, Rose, understood that she gained as much from her planning and mentoring work with Bob as he did. Bob’s identity matched well with the identity expected by the larger school, and he quickly worked to become a competent member of this activity system.

Contextual Factors and First-year Teachers

The second set of research questions require a focus beyond the subject in the activity system, to understand the contextual factors of the activity systems and how these factors interact. Blending the fundamental trajectories of CHAT (Engeström, 1999) and situated learning (Lave & Wegner, 1991), this research emphasized these two beginning teachers’ interactions with their context during their first year in teaching. The teachers’ transformation to teaching professionals varied, based upon interactions of who they were as teachers and the context in which they worked.

I understood the transformation that occurred in these novice teachers to consist of internalization and externalization in a sequence. Lave and Wegner (1991) also summarize this transformation:

It crucially involves *participation* as a way of learning—of both absorbing and being absorbed in—the “culture of practice.” An extended period of legitimate peripherality provides learners with opportunities to make the culture of practice theirs (p. 95).

For these novices, participation in their first-year activity systems allowed for a period of intense engagement as they worked to internalize the context of their first-year activity system through their attempts to become a competent member of their community. In their efforts to assume their full roles in their activity systems, Nathan and Bob confronted coherences and contradictions. The coherences served to strengthen particular patterns of thought and practices. Contradictions, on the other hand, caused

one of the participants (Bob) to look for ways to modify his activity system, to search for pathways allowing him to become a more competent member of his context. The other teacher (Nathan) responded to contradictions by changing the object of his activity system to that of surviving the first year, with the goal of eventually becoming a competent member of a different activity system (i.e., another school, university academic, or science education lobbyist).

In this section I explore the contextual aspects of CHAT that played the most significant roles in shaping the activity systems of these new science teachers, their local and wider school communities, and the rules for their activity system.

Community

The communities of these teachers played significant roles in molding their first year experiences. The communities were essential in providing a work environment that allowed the novices to master necessary skills and allowing for innovative learning opportunities. In these communities the novices learned to solve contradictions and refine their teaching identities.

Classroom--Interaction of Identity and Emotions

In a socially-situated perspective on learning, the incentive for acquiring new information and skills does not emerge only from intrinsic interest in the activity, but also from the aspiration to contribute as valued members of a community (Olitsky, 2006). Some argue that teaching goals involving students' sense of belonging are crucial to understanding classroom learning because if students do not feel a sense of membership in the science classroom, they may fail to engage with the material to be studied. As importantly, without this sense of membership in a classroom community, science will not become part of their identities and they will be unlikely to seek out interactions involving science in the future (Brickhouse, Lowery, & Schultz, 2000; Olitsky, 2006). Thus if one is to understand science learning, one must understand the way a teacher establishes or fails to establish a sense of community in the classroom.

This research demonstrated that the emotional energy that each teacher was able to generate for creating a sense of community and welcoming students into this community influenced both their enactment of science reform and provided for their

students' effective learning experiences. Through his consistent use of inquiry-based collaborative activities, Bob was able to generate a positive emotional energy that empowered his students (even the ones who were not interested in learning science) to feel that they were part of the collective activity within Bob's classroom. Additionally, to structure this sense of collective activity in his first-year activity system, his emphasis on NOS and classroom rules played a significant role in allowing his students to grow accustomed to their new roles as learners in inquiry-based classroom. His students developed a sense of group membership associated with science, which essentially emerged from dependable, increasingly familiar solidarity-building interactions through activities requiring group work in his classroom (Olitsky, 2006). Students knew what was expected of them, they found the activities engaging and enjoyable, and most reveled in his attention. They understood Bob's goal was for them to learn physical science, and he could be depended on to be a source of aid in their efforts--thus they felt comfortable pointing out when they were not learning, when they needed additional help. The emotional atmosphere in his classroom was positive, often lighthearted, and energetic, and most of his students seemed to thrive.

While much of their classroom practice echoed each other in the early NOS lessons, Nathan's lack of emphasis on classroom procedures and management, his emphasis on his role as student friend, and the lack of emphasis given to planning soon made Nathan's classroom a much different place from Bob's. Nathan's lecture-based teaching imposed upon his students the primary role of listeners, negating opportunities for active participation except in reaction to Nathan. Some of the idle students soon posed management problems for which Nathan had no procedures to deal. These difficult students contradicted Nathan's identity as competent and a champion of the student, eliciting negative reactions from both Nathan and the students. Without a strong classroom community, without the students' sense of Nathan's high expectations and support, he was not able to generate collective science learning opportunities for his students.

As described by Friedman (1996), beginning teachers' ineffective experiences can lead them toward (a) a cognitive pathway involving a sense of personal and professional dissatisfaction, and (b) an emotional pathway that evolves into an initial sense of

overload, followed by a sense of emotional exhaustion. In the sense of cognitive realization, Nathan attributed most of his sense of discontentment to the contextual factors of his teaching not to his own ineffectiveness in teaching. For the emotional part, Nathan's sense of overload served to stress Nathan, leading him to feel that his position was excessively burdensome. Nathan quickly became emotionally exhausted and disappointed, compromising his willingness to invest himself in this teaching, his motivation to persist in the face of obstacles and defeat, his resilience and endurance to resolve the contradictions in the classroom and in the broader school context (Bandura, 1997; Friedman, 2000).

The emotional energy of these two classroom communities were not simply influenced by the student-centered to teacher-centered teaching approach or the presence or absence of firm management protocols. Instead, I argue that these communities were also influenced by the way in which these two teachers talked about science with their students. Bob's successful facilitation of daily life applications of science content helped his students to gain a mutual focus for successful interactions with a profound comfort level of talking about science. In contrast, Nathan's limited content knowledge in Earth Science restricted his ability to relate Earth Science content with his students' daily lives. As a way to compensate for this while still reaching out to students, Nathan brought in social and political issues to discuss during his classroom. However, the monological nature of these discussions appeared to be fruitless in eliciting his students' motivation. While Nathan may have been interested in politics or elections, his students were not.

Echoing their teachers, the identities these teachers' students were developing different. Bob's students were asked to practice new roles as inquirers, investigators, and collaborators during the course of Bob's first year teaching. Nathan's students, on the other hand, were asked to listen and conform. (Ironically, this identity of conformer was what the Kent High School administration expected from Nathan during his first year teaching as a beginning teacher.) Bob's students, by and large, rose to the challenge and rewarded Bob with their high degree of engagement and solidarity--as his students seemed to strive for the goals he set for them. Many of Nathan's students began to reject their roles of listeners in Nathan classroom, acting in ways other than those hoped for by Nathan and actively working to halt progress toward his teaching goals (i.e., using their

cell phones, taking back to Nathan in harsh ways, and refusing to listen). Bob found his classroom community invigorating and stimulating, while Nathan became progressively more exhausted by his students.

School Community

It is important to recognize that teachers work, not just in their classrooms, but in broader context, in departments and schools, and these broader levels of context have an influence on teachers' activity systems. Most obviously, Nathan and Bob worked in different levels of schools, high school and middle school. It is important to understand how the nature of these levels of school shaped their activity network. But, too, these two schools represented very different kinds of schools in terms of social capital. In a later section, the salience of this social capital on our novice teachers' activity system will also be explored.

Grade Level Differences. As outlined by Forte and Schurr (1993), there are significant differences between middle and high schools, particularly different ways of understanding the meaning of schooling. Using this work, I understood the teachers' work places to illustrate these following differences:

1. High School Teachers are more aligned with other members of their disciplines and have little interactions across disciplines. This accounts for the sense of competition that existed between disciplinary teachers at Kent High, in contrast to the strong sense of community fostered at Lake Middle School. Lake's sense of community was seen, not only between teachers, but also between teachers/administrators, teachers/parents, students/teachers as well as students/students,
2. In Lake Middle School teachers worked in combinations of grade level teams with common planning time. On the other hand, teachers in Kent High School were organized by content departments, with no common planning time. Teachers' work was facilitated by a joint work area for all grade level teams at Lake as opposed to disciplinary areas at Kent.
3. Lake Middle School encouraged multiple teaching strategies facilitated with high level of interaction among students and teachers, and such teaching

was the norm. At Kent, a text-book oriented teaching style with a high degree of teacher talk was the norm.

4. The Lake Middle School culture institutionally empowered teachers, with a strong sense of the role of administration as facilitator, providing teachers with the essential emotional, professional and financial supports. The Kent High School culture appeared to place most of the power for decision making with the administrators. The role of administration was to control all curricular and extracurricular activities at the schools.

These differences between middle schools and high schools are both relatively common (Forte and Schurr, 1993) and very influential in terms of teachers' practices. Bob, with his collaborative identity, found Lake Middle School's community comfortable and rewarding. He was quickly drawn into this community. The competitive, largely individualistic community of Kent High School allowed Nathan's teaching to unravel with little input or insight from others. This unraveling was bolstered by the competitive atmosphere. Nathan, being dramatically shaken by the administration, then rejecting the expertise and support of other teachers, and finally being rejected in his role as a friend to his students, was on his own.

Capital Differences. Aside from the grade level differences, it quickly became evident that each school held distinctly different institutional features at the center of their activity systems. According to Achinstein et al. (2004), school context of teachers possesses four different forms of capital: (a) human capital; (b) social capital; (c) physical capital; and (d) cultural capital. Based on this, it is important to note that there existed crucial differences between Kent High School and Lake Middle School in terms of the wealth they held. Lake Middle School's human capital, which includes professional knowledge and skills, views regarding learning, and commitments and dispositions to learn about reform (Spillane & Thompson, 1997), was reflected in its curricular practices and the professional development activities offered to its teachers. The same was true for Kent High; however, in this case the reflection was much more antagonistic to reform.

There were also critical differences between these two schools in terms of their social capital, which involved relationships, a sense of trust and collaboration with colleagues, and ties to outside experts and professional networks (Spillane & Thompson,

1997). Lake Middle was characterized by a strong sense of collaboration among teachers within and across the grade level teams and a strong sense of trust between teachers and the administrators. Lake Middle also valued the professional networks through welcoming the academic research requests like this research. Since the institutional structure of Kent High School placed much of the power in the school in the school administration the sense of trust and collaboration among the teachers and administrators was scant, and in Nathan's view, there was little collaboration even between teachers.

As far as the physical capital, which included financial resources and supplies essential to teaching and learning activities (Marsh, 2002), there was a vast amount of difference between these two schools. The academic departments at Kent (particularly the science department) were in need of instructional materials because of the school administration's financial policies favoring extracurricular activities over academic need. On the other hand, because of the strong collaboration among the teachers and the school administration, Lake Middle School allowed relatively easy access to materials essential to teaching and learning activities. While financial sources for teachers to support their instructions were limited and accessing these resources burdensome in Kent High School, teachers in Lake Middle School enjoyed the availability of existing resources and uncomplicated accessibility to those resources.

Finally, there were also critical differences in the cultural capital of these schools. Cultural capital included the factors stemming from students' and parents' access to the cultural attributes associated with privilege (Bernstein, 1990; Metz, 1990). It was important to note that Kent High School and its "feeder" middle schools were located in a neighborhood that served low-income and minority families, whereas Lake Middle School was surrounded with a neighborhood which included middle class, ethnically diverse families. While the Lake Middle School community seemed to take their diversity as strength, the student body of Kent High School appeared to be a source of contradictions for teachers. At Kent, the working class student population was very different in many ways from the teachers--thus these students often represented a challenge to the teachers in terms of motivation, engagement and management. Indeed, such situations can lead teachers to question the school administration's policies as being too accepting. This was not the case at Lake Middle School.

It would be tempting to categorize the difference between these two schools as simply that expected as one compares urban and suburban settings. That would be overly simplistic. A close look at the cultural capital of each school revealed that there was a reciprocal relationship between schools' perception about parental involvement and parents' willingness to involve. The parents of Lake Middle School seemed to be willingly involved in the curricular and extracurricular activities. The overall welcoming attitude of teachers and administrators of Lake Middle School encouraged parents to be active in the school activity system. However, at Kent, high parental involvement was not a priority for the school administration. The influence of the low cultural capital also became apparent at the level of teachers' commitment to motivate their students to excel school. While positive interaction of outside culture and the school culture cultivated a sense of commitment shared by teachers to provide most effective teaching opportunities for their students in Lake Middle School, a negative relationship between these two cultures resulted in allowing for perpetually lower teacher expectations for students.

Support systems. The schools also differed in terms of the amount, effectiveness and the quality of support opportunities afforded to new teachers, and this support proved tremendously important in these novices' activity systems (Grossman et al., 2002; Spillane & Thompson, 1997). Both schools had a support system for beginning teachers, however, their effectiveness and intensity varied. At Lake Middle School, along with the support provided by the entire school community and the 8th grade team, there were four different support sources including (1) mentor teachers, (2) teacher "mom", (3) student substitute, (4) student intern. The readily available sources of support combined with Bob's communal identity helped Bob his teaching goals and eventually become a competent part of Lake Middle School.

In Nathan's case, Kent High School provided two main support opportunities for Nathan; (1) mentor teacher, and (2) first-year teacher counseling. In spite of their existence, the effectiveness of these two support sources was limited. Nathan's self-sufficient, competent teaching identity caused him to find flaws with these resources and fail to access them. Nathan, in part, chose to flounder on his own, and he was allowed to pursue this solitary path.

Emotional Differences. An exploration of the different social supports that Bob and Nathan received underscores the criticalness of positive emotional energy for beginning teachers. Bob explained that at the end of his first year, he was happy at Lake Middle School and he couldn't envision himself working elsewhere. In contrast, a blend of both weak social support and clashing personal and institutional identities created a negative emotional energy that led Nathan to search for other activity systems for positive recognition. Collins (2004) explains that when individuals lack an immediate social support, they turn to possible sources of emotional strength. Thus, for Nathan, graduate school provided immediate social support and positive emotional energy. Ultimately, for Nathan, pursuing a graduate degree became attractive as he lost his drive to become a community member at Kent High School.

Rules

A final aspect of the activity system that proved to have particular salience for these novice teachers' activity systems was that of rules. While the rules that emerged as important influenced both Nathan and Bob, the rules often had very different significance for the two novices.

State Assessment Policy. The current state policies on standardized curriculum and standardized achievement testing in response to No Child Left Behind legislation have a potent impact on teacher practices (Achinstein et al., 2004; Ogawa, Sandholtz, Martinez-Flores, & Scribner, 2003), particularly in science (Southerland, Smith, Sowell, & Kittleson, 2007; Yore et al., 2007). Some literature suggests that state level instructional policies may provide new teachers with a certainty about what and how to teach through specifying certain standards, curricula, and pedagogy (Schmoker & Marzano, 1999). Those who support the benefits of state level policies argue that standardized curriculum and achievement requirements raise the quality of instruction, improved student achievement, and thus promote equity across educational settings (Slavin, 2002). According to this view, state policy implementation holds special promise to help beginning teachers who work in low performing schools.

Kaufman et al. (2002) specified that schools with challenging conditions are often unable to provide needed guidance for beginning teachers. They argue that these state

level standardized curricula and achievement requirements may play essential roles in guiding beginning teachers who are “lost at sea” in areas of curriculum and instruction (Kaufman et al., 2002). Additionally, the advocates of these state level educational policies also emphasize that when academic standards and accountability provisions are well developed and implemented system wide, they lead to superior coherence and more challenging curricula, build collaboration among teachers, increase the quality of teaching, and focus on improving achievement (Gandal & Vranek, 2001).

On the other hand, researchers who criticize the state level educational policies argue that accountability and authoritarian instructional policies narrow teachers’ professional judgment, discourage effective instruction, and focus on lower order learning opportunities such as bookwork and lecturing (Darling-Hammond, 1997; McNeil, 2000). They note that in the absence of clear description of appropriate pedagogy, accountability measures that focus only on student achievement in the short term often support the adoption of teacher-centered teaching approaches targeting rote knowledge gains in students (Southerland et al., 2007). Historically low performing schools tend to adopt such instructional approaches, however such prescriptive programs compromise opportunities for students from low-income and minority backgrounds to pursue higher order knowledge and skills. Thus accountability measures actually work to increase the inequities in the society (Berliner, 1992; Darling-Hammond, Wise, & Klein, 1999; Shulman, 1987; Southerland et al., 2007; Sykes, 1999).

In this research, accountability policies played different roles in each teacher’s activity system based on the vulnerability of these schools to state policies. As suggested by other researchers (Hoffman, Assaf, & Paris, 2001; McNeill 2000; Moon, Callahan, & Tomlinson, 2003), because of their low performance in state achievement tests, the school with low capital appeared to face greater pressure from educational accountability measures and are more likely to emphasize direct instruction and predefined lessons to improve students’ performance on standardized achievement tests. Kent High School’s history of low performance on state measures placed significant pressure in this school. The school administration strictly controlled the teaching and learning activities relevant to state expectations—including reading time in all subjects and math drills in all periods. At the outset of the year, these autocratic requirements supported Nathan’s rejection of

any utility for such measures. Ironically, by mid-semester in teaching, Nathan internalized the administrations' stance on standardized test scores. Nathan came to understand the state's stance on standardized test as a way to ensure the attainment of minimal standards by all students, and he struggled to find a suitable role for reform based strategies within this context.

In Bob's case, given Lake Middle School's history of success on the state's accountability measures, the state educational policy implementations did not appear to be the strong driving force for teaching and learning activities. Teachers in Lake Middle tended to plan their classroom mindful of what they considered to be "good instruction"--confident that such instruction would allow students to be successful. Rather than preparing their students to state achievement test, they placed significant emphasis on their students' effective preparation of their future education as well as students' personal lives. Into his first year of teaching, Bob continued to champion the use of statewide assessment practices. However, such policies remained in the background for Bob; he understood that state standards outlined the essential content that his students needed to learn. The state standards for physical science helped Bob to know the primary content requirements. Based on this foundational content, Bob placed a vast amount of interest in broadening his students' understanding to achieve high standards specified by NSES (1996).

First-year teacher Support Program. Like all other beginning teachers in their school district, Bob and Nathan attended the mandatory first year induction program organized by the District. The purpose of this program was to inform and provide essential support for beginning teachers to become competent members of the county's educational system. In the light of state educational policies, the program specifically focused on the necessary competencies to ensure the quality of education that all students in the District received.

A close look at the effectiveness of this program for supporting Bob and Nathan demonstrated that the program created a burden related to time constraints for these beginning teachers--and simultaneously failed to provide another learning community for these novices to rely upon. Both teachers came to an understanding that the timing for this program created a serious constraint in their demanding first year schedules.

Too, the content of the county's first year support program appeared to be another source of contradiction for Bob and Nathan. For both Nathan and Bob, the content of this program was a replication of their preservice education program. Although they both understood that participating in these sections definitely played a crucial role in helping those who did not have a strong preservice background, they recognized that their participation of these sections failed to help them.

Discussion

The focus of this research was to develop an understanding of the activity systems of first year, reform minded science teachers, and the changes that occur in these systems over the induction year. Using CHAT and situated learning as the major theoretical frames, this study focused both on these young science teachers as individuals and the context in which they worked to understand the interaction of the personal and the contextual in the first year of science teaching.

The Importance of Considering Personal and Institutional Identities

It is important to note the difference in these two teachers' prospective objects of their first-year activity systems. Although both teachers left their preservice experience anxious to enact reform-minded practice, there appeared to be a fundamental difference between these teachers' primary objects, which were reflected in their choice of schools for their induction year. Nathan was an idealist first-year science teacher who envisioned himself as a change agent whose primary purpose was to make a difference in both his students' lives and the general context of his school. Indeed, because of the historical and cultural realities of Kent High School, Kent appeared to be the ideal place for Nathan to achieve his teaching goals.

On the other hand, Bob, with a communal identity, selected Lake Middle School because of its supportive school context. Bob structured his first year object as becoming a competent member of his school environment as well as seeking opportunities to practice what he believed to be effective science teaching based on his knowledge and experience gained during his preservice period.

Much like an individual's personal history, institutional histories also generate distinct institutional objectives for activity systems. Kent High School and Lake Middle

School had different institutional objectives. Kent High School's long term underachievement in state wide achievement testing led the entire school to focus on increasing the yearly progress and achievement scores of the school. In contrast, given their enviable status on statewide assessments, the main goal of Lake Middle School was to provide most effective teaching and learning opportunities for its members. Too, the solidarity observed among the community members in Lake Middle School allowed for profound induction experiences for Bob; the lack of solidarity among the Kent High School community combined with Nathan's individualistic, competent, nontraditional teacher identity interacted to leave Nathan relatively isolated in an increasingly difficult teaching position.

The interaction of both contextual and individual facets of these two activity systems generated contradictions and coherences that played significant roles in these beginning science teachers' object formation. The research illustrates that the contradictions in each beginning science teachers' first-year activity systems allowed for innovations to change the activities of these teachers' first-year activity systems.

As shown in Figure 8-1, when the contradictions are mild or moderate, as in Bob's case, even first-year teachers are able to begin to focus on their practice, critically reflecting on it, and allowing for refinement. Thus, by the end of his first year teaching, Bob began to refine his use of reform-minded teaching practices. When the contradictions are overwhelming, as was seen in Nathan's case, the novice teacher is unable to focus on the effects of his practice, instead his focus is shaped by an extreme contextual discontentment. Extreme contextual discontentment leads a novice to a completely new object for his activity system--that of surviving the year. For Nathan this new object drew energy and motivation away from any consideration of reform minded practice.

The Interactions of Community and Identity in Shaping Novice's Goals

This study also confirmed the criticalness of beginning science teachers' participation in the community of practice for their professional development (Bianchini & Cavazos, 2007). Participation in a broader community was particularly essential for their development. The school with high capital used effective interaction rituals to

generate a positive emotional energy among the community members. In this research the Lake Middle School community provided a profound sense of belonging for Bob, and allowed him to generate an institutional identity as a science teacher with a full access to participate in the community of practice. The opportunity for Bob to collaborate and have ownership in curricula and assessment activities benefited not only for Bob but also other community members. His strong collaboration allowed Bob to generate and maintain a successful personal science teacher identity. This collaboration also resulted in a strong positive energy, allowing Bob to continue to work to become a competent member of his department.

In contrast, Kent High School imposed an institutional teacher identity for Nathan that required him to obey the rules and support the status quo--an identity in direct conflict with his own teacher identity. A strong control-oriented leadership of the school combined with the low social capital of the school to echo the “pedagogy of poverty” (Haberman, 1991). Nathan came to understand that Kent High School’s problems were due to the realities of the low school capital and ineffective administration. Thus, the limited opportunity to contribute and take part in the wider activity system not only hindered Nathan’s primary object to make a change in the entire school system but also prevented Nathan from developing a sense of belonging in the Kent High School community.

This research also confirmed a reciprocal relationship between context and identity of beginning science teachers (Sfard & Prusak, 2005; Enyedy et al., 2005). Identities and dispositions of these teachers played significant role in these teachers’ attempts to become a competent member of their school communities. It became evident that Nathan’s identity restricted his receptiveness and openness to explore the support that was available for him during his first year teaching. The contradiction originated from his competent, nontraditional identity causing him to reject offers of support and even failing to recognize resources that were available. A blend of low capital of Kent High School and Nathan’s identity prevented Nathan from participating in the community of practice available for him at Kent High School. Given the interactions of the context with his personal traits, very close to the beginning of his first year Nathan made the decision to leave Kent High School at year’s end.

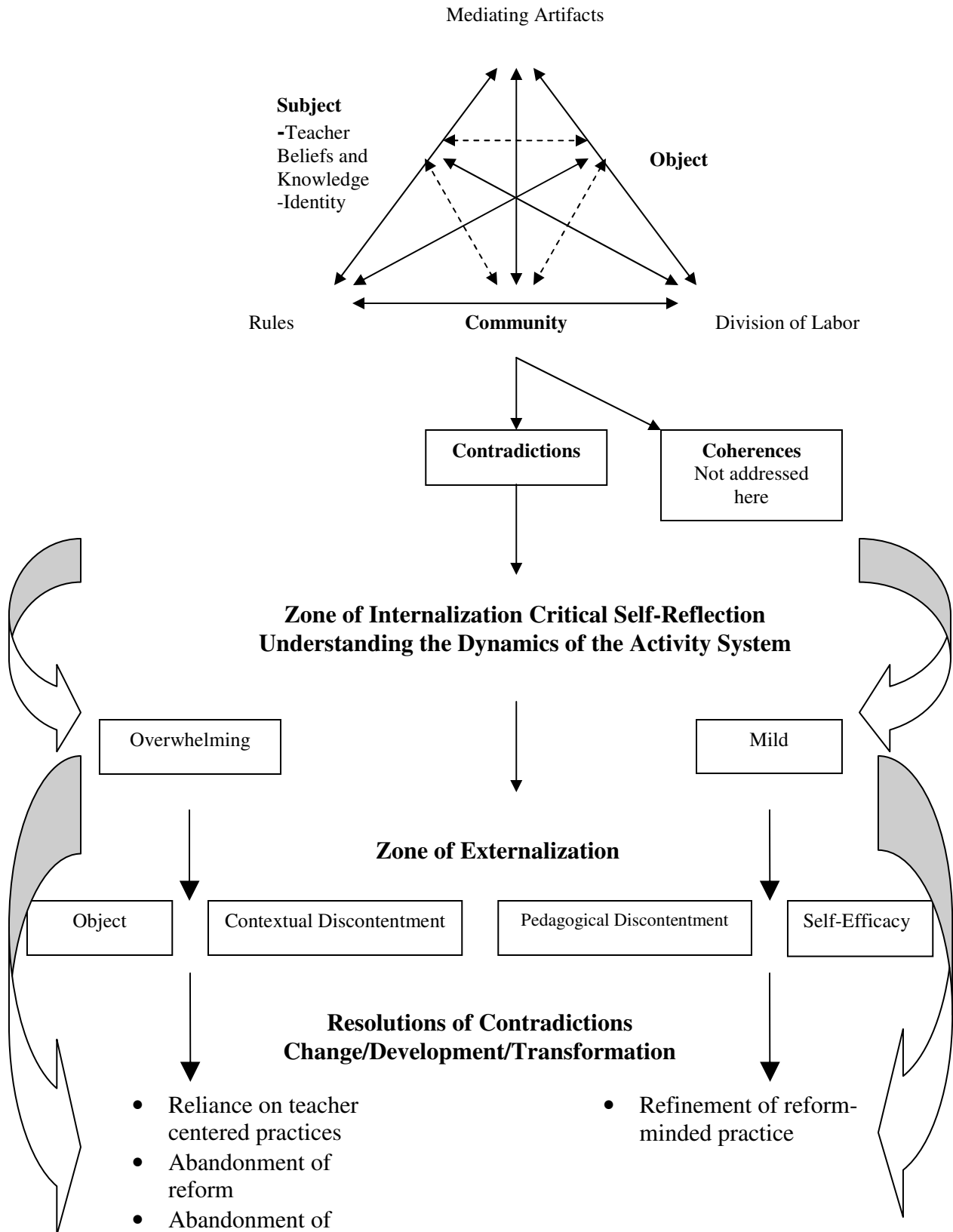


Figure 8.1: Interactions of the personal and contextual in contradictions

Bob's relatively communal identity caused him to value the opportunities presented, and he actively engaged in the community of practice at Lake Middle School. Consequently, in the reciprocal relationship observed between beginning science teachers' personal and institutional identities and the context, beginning science teachers' identities appeared to be extremely important when these teachers start their first year-- and this is particularly true when teachers enter a difficult school context.

Degree of Contradiction Determines Revision of Practice or Abandonment of Objects

Another principle of the CHAT framework describes the possibility of expansive transformations in activity systems of novices as a result of novices' critical reflection and questioning of the contradictions embedded in their activity systems. The observed externalization of these beginning science teachers was not limited by their identity formation; several other changes and transformation occurred as a result of their attempts to resolve these contradictions (as shown in Figure 8-1). The more mild contradictions experienced by these beginning science teachers' allowed them to work to resolve these contradictions through more small scale changes in belief or practice. The process of internalization and externalization allowed one of the novices to affirm his beliefs about science teaching and caused him to restructure these beliefs to be more deeply held; thus, Bob became even more convinced of the central aspects of reform after his first year teaching.

On the other hand, with lack of internalization and externalization opportunities, beginning science teachers' beliefs about teaching and learning can become superficial. Thus, in the context of the significant contradictions in his activity system, Nathan's beliefs about the reform became even more superficial and thus were easier to discard, as described by Smith (2002).

These beginning science teachers' high personal teaching efficacy remained stable throughout much of the year with a slight fluctuation. Instead, the contradictions they experienced were more influential in terms of shaping their outcome expectancies. The change generated in Nathan's case appeared to originate from various sources including low student motivation, lack of supplies essential for effective science teaching as well as lack of community involvement. On the other hand, students' home lives as an

essential facet for their motivation to learn appeared to be the most crucial reason for the change in Bob's outcome expectancy.

As opposed to pattern changes in self-efficacy beliefs of these teachers, this study illustrated different patterns of change in terms of pedagogical discontentments. From a cognitive perspective, teachers' contradictions and discontentment provide resources and opportunities for personal development and functioning (Bandura, 2000a; Sowell et al., 2006). Based on the findings of this research a sense of pedagogical discontentment is essential for the continued development of and refinement of science teaching practice. For example, Nathan perceived the vast amount of contradictions in activity system as contextual in nature, thus the remedies for these contradictions were not his responsibility but that of the entire system of education. Nathan experienced very little pedagogical discontentment and made no progress in refining or developing his teaching practice. However, Bob recognized the contradictions embedded in his specific activity system as caused by facets of his teaching that required improvement. His pedagogical discontentment caused him to continually search for ways to improve aspects of his teaching.

As far as the changes observed in these teachers' objects and their own teaching goals, it is important to note that the contradictions or coherences between these teachers' individual objects and their communities' institutional objects played significant roles in their object formation. The difference between Nathan's individual object and his school's institutional object appeared to be a contradiction that significantly influenced Nathan's object formation. Although he started his first year teaching with an immense amount of idealism to make a great impact on his students, as well as the entire school community, his primary object changed to simply "surviving" his first year --leaving a reflection and refinement of his practice as something to wait until the context proved more promising. In contrast, because of both individual and contextual characteristics, many of the contradictions that emerged from Nathan's activity system remained unquestioned or generated such a strong emotional reaction that Nathan had to change the object of his activity system--leaving the school and eventually leaving teaching.

Bob's first year object formation illustrated a different pattern. At the beginning of the school year, Bob's object was to become a competent part of Lake Middle School

community and to enact aspects of science education reform in his classroom. During his first year Bob became an effective member of his school community, and he found the space, time, and collaboration needed to closely reflect and refine his reform-minded practice. Thus, he left his first year with the object of enacting more reform-minded science teaching in his following year.

The Activity System of Novice Teachers: Changes and Their Causes

It is well known that the first years of teaching are demanding as the novice works to gain a degree of familiarity in her/his professional work. It is during this period that many science teachers decide to leave the teaching profession or move away from the reform-minded practices acquired during their teacher preparation programs, or they become more committed to the work and begin the process of refining their practice. I undertook this research to understand what happens during their induction period. I found that:

- Teaching identities and the way they “fit” with or correspond to the institutional identity fundamentally shape a novice’s induction year.
- Participation in a professional community that both acknowledges the strengths novices bring into the community and recognizes the support novices need is essential.
- Contradictions in the activity system of novices are of primary importance: If they are moderate, they can serve as catalyst for changes and the refinement of teaching practice. If they are severe, they can halt any refinement and may force the novice away from teaching.

The Fit of this Research within the Science Teacher Induction Literature

This section outlines how the themes emerging from this research echoed the previous research into the induction of science teachers.

In an early study on science teachers’ development stages, Spector (1989) discussed that in their induction stages, beginning science teachers typically focus on their survival within the school environment. During this stage, novice science teachers are thought to be absorbed in the conflicts between their preservice learning and the realities of actual classroom (Spector, 1989). In contrast, the findings of this research

illustrated that science teacher's induction stage can provide an opportunity to go beyond survival concerns and work to refine their teaching practice. That said, when the contradictions in the system are too overwhelming, novices can be trapped in this survival stage. Thus, Spector's discussion of teacher development needs to be seen not simply in professional chronological terms; instead development can be accelerated when the contradictions in the novices' activity are minimal.

Drawing upon her research on the interaction of context and teacher beliefs, Smith (2005) suggested that the physical and social contexts in which teaching and learning take place are an integral part of teaching and learning activities. The situative perspective on learning focuses on interactive systems that include individuals, as participants, interacting with each other as well as physical and social contexts (Cobb & Bowers, 1999; Lave & Wenger, 1991). This perspective is visceral to the findings of this research.

This research confirmed that differences between values of the school and teacher education programs play a significant role on shaping first year teacher's induction experiences (Bullough, 1989; Zeichner & Tabachnick, 1981). Echoing to McGinnis et al. (2004), the findings of this study suggests that the school contexts in which beginning science teachers began their professional lives heavily influenced the extent to which teachers' enactment of science education reform. Because of his supportive context, Bob was able to successfully implement his teaching philosophies and enact his theoretical and practical trajectories of science teaching. Because of his contradictory context, much of Nathan's reform-based intent "washed out" during his early days in teaching. Indeed, this study supports the wide array of research that suggests that the school culture and cultural capital also influence the degree to which novice teachers can find a professional space in which to refine their teaching practice (e.g., McGinnis et al., 2004; Bullough, 1989; Mohr, 2002).

Additionally, my findings also support research that describes that a sense of belonging to a school community (Collins, 2004; Olitsky, 2004, 2006) and participating in professional development activities (Putnam and Borko, 2000; Roehrig and Luft (2006) are essential in shaping beginning science teachers' high self-efficacy beliefs and commitment to work environment, while moving these novices toward reform-based

teaching practices (Friedrichsen et al., 2006; McLaughlin & Talbert, 1993; Wong et al. (1999). This research further supports that the required skills to become an effective science teacher are associated with maintaining and enhancing one's sense of self as worthwhile and a contributing member of a profession (Bullough, 1989). More broadly, this study illustrates that there is a dialectical and mutually constitutive relationship between the person and community. So the nature of a novices induction experiences are shaped both by the individual and the contextual.

Beyond contextual influences, findings of this research support the existing literature, which found that individual factors also play crucial role in shaping the experiences of first year science teachers (Bullough, 1992; Gratch, 2001). Specifically, through strengthening personal teaching philosophies and practicing them in teaching tasks such as curriculum design, beginning teachers avoid loss of self. Although previous research underscores individual aspects of first year teaching, they provide little empirical insight how these personal attributes affect experiences of novice science teachers. As opposed to general understanding of such influence in existing literature, this research illustrated that personal and professional identities and emotions of beginning science teachers' were significant factors of their first year activity systems.

Gratch (2001) reported that the success of beginning teachers in meeting the needs of their students is influenced by the success of these beginners in negotiating complex cultures of the teaching environment as well as their ability to reflect on internal beliefs and expectations for oneself as a teacher. Specifically, this research emphasized that identities of novice teachers significantly influenced teachers' attempts to become a competent science teachers. Gratch's work and the findings of this research help us understand that the influence of identity as well as emotions influences a wide range of social and professional development of teachers.

The findings of this research also confirmed those of Luft (2007) and Wong et al. (1999). They asserted that available professional and emotional supports are critical for development of beginning science teachers. Wong et al. (1999) explained that professional development activities and support resources offered to beginning teachers can be a help or a burden. As suggested in the findings of this research, their usefulness depends on when such activities are offered and how applicable and valuable the content

is perceived to be by the novice teachers. Based on this research, ensuring the effectiveness of inservice activities in meeting the needs of beginning teachers is critical. Clearly surveying beginning teachers before activities are determined is wise. Wong et al. (1999) also suggested giving novice teachers the choice to attend a specific inservice activity or generate inservice programs with a choice of topics built into them. All of these suggestions appeared to be essential for the participants of this research. Finally, scheduling these support programs before the school year might release the burden of beginning teachers and increase their receptiveness to these programs.

Implications

There are a number of implications of this research for science teacher educators, school faculty and district administration, and educational researchers.

Teacher Preparation and Induction Programs

This research suggests that we should reconceive induction--moving beyond our portrayal of induction as a “box” of time that occurs after student teaching. This research demonstrates that the development of a teacher is much more longitudinal and organic. Thus, induction programs need to be much more individualized to build upon beginning teachers’ individual differences, something district wide “one size fits all” programs are unable to do. We must recognize that induction is a continuation of what has happened to the teacher throughout their lives. Mindful of this, the support networks from preservice should be extended. We need to re-conceive the development to of a teacher induction as a function of what happens before this period, and the support required during this time should continue. Induction support needs to draw on beginning teachers’ past experiences and should be designed more at an individual level.

This work, like that of Bianchini & Cavazos (2007), points to the important role professional development communities play in the development of reform minded science teachers. Teacher preparation programs should include a close examination of the role and importance of communities in a teacher’s initial success and long term development. They should allow preservice teachers to recognize the role a community plays. Clearly disbanding the professional community constructed throughout a preservice experience upon graduation is artificial and counterproductive. Instead,

induction programs that, in part, include the preservice science teacher community may be invaluable for providing support, recognition, and critical lens for novices to examine their work as they move into schools as professionals.

School faculty and school/district administrators should recognize the pivotal role community plays and work to create authentic communities that acknowledge and build from the skills and knowledge novices bring with them as well as offer support. Programs that are seen only as requirements, as sources for potentially unneeded remediation, or that do not change form to acknowledge the novice's abilities and knowledge, can actually be counterproductive as they require a time and energy yet provide little sense of true community.

Teacher preparation programs should support preservice teachers in an exploration of their teaching identity, as well as explore the fit of this identity with that of the prospective schools. If much of a novice's comfort and eventual success is shaped by the way in which they "fit" into a school community, novices should be cognizant of this. Science teacher education must become broader than a focus on student learning. It must be recognized that effective communities are particularly needed when novices teach in challenging settings. This research adds to the tradition of Brooks (2006) that effective professional communities must go beyond occasional observations and quick talks in the hall. Instead, again these communities need to emphasize the strengths and abilities novices bring with them, as well as offer portraits of what effective teaching can look like in the school setting. Novices need to be recognized as capable but developing. Effective professional communities must play a role in both.

Perhaps of most importance is the need for science teacher preparation to expand its vision--to focus not just on student science learning, but also on science teacher professional development, on schooling as influenced by wider social, contextual and structural conditions. For instance, in addition to an emphasis on reform-based descriptions of teaching and learning science, science teacher preparation programs should make more explicit the role support plays in the professional development of teachers, thereby allowing candidates to be mindful of this construct in their choice of positions, and the way they interact with colleagues once they accept a position. Too, teacher preparation must go beyond simply emphasizing teaching and learning, but it also

must begin to address strategies young teachers can use to access the support they need to be able to consistently enact reform based practices.

Finally, for too long science educators have been silent about the role standardized testing plays in shaping the kinds of teaching that occur in classrooms. Throughout the teacher preparation program there must be sustained analyses as to how reform minded teaching can support the learning required for statewide standardized tests (Southerland et al., 2007). When the needs of a state test are incongruent with the kinds of learning called for in reform, that incongruity needs to be examined and explored and experienced teachers who have “found a way” to be effective in this context should be used as a methods resource.

In short, this research emphasizes the need to bring the realities of being a professional in a school into the preservice experience, and to extend the support begun in this experience throughout the induction experience. Novice teachers can be successful and refine their practices of science teaching, but that success and that movement is a function of both the individual and the context.

Research Implications

As far as the methodological implications of this research, use of CHAT in educational research especially in teacher induction provides unique perspective for researchers addressing interactions between individual and contextual aspects of an activity. Thus, CHAT allows researchers to understand this essential interplay through their prolonged engagement exploring an activity system under investigation. To construct a profound understanding of broad patterns from an activity system; researchers need to pay explicit attention to multiple facets that constitute the entire activity system being studied. That said, CHAT comes with practical costs. The complex understanding it allows the researchers is a burden because of that very complexity. Given page limits of journals and cognitive capacities of readers, it is difficult to share the meanings taken from such complex research. Yes, CHAT allows for unique insights, but I continue to struggle with appropriate vehicles to share these insights with others so they may be of wider use.

Future Research

Luft (2007) described that science teacher education has focused on preservice and in-service teacher education for too long, to the detriment of beginning, induction and newly qualified science teachers. Since this phase of science teacher development is unique in the life long development of science teacher, she emphasizes the importance of creating support programs for beginning science teachers. Luft (2007) indicated:

Contributions to our understanding of science teacher induction are just beginning, and they fill a gap that has historically only addressed preservice and in-service science teachers programs. We are just starting to “mind the gap”, and our forthcoming studies will contribute in significant ways to our understanding of the development of science teachers. (p.536)

This research provides a profound account of the interaction of individual and contextual factors on beginning science teachers’ development. I argue that more research is necessary to map the development of novice science teachers while searching for ways to invoke systemic changes to allow for the continued development of reform-minded science teachers (Blanchard, 2006; Gess-Newsome et al., 2003; Southerland et al, 2007).

I suggest that induction of beginning science teacher is not limited to their first year in teaching. Ideally, the first several years in teaching should be considered as induction and multiyear studies that focus on the initial years in the profession may provide a better account on novices’ professional development.

This research clearly demonstrates that the emotional preparation of beginning science teachers for possible contradictions in their work environment is essential. Along with the research focusing on emotional preparation of novice science teachers, research focusing on professional and personal identities of preservice science teachers and their fit within schools seems particularly useful if we are to keep novices in the profession in greater numbers and with greater effectiveness.

Recently the concept of communities of practice and interaction rituals have become a focus of some aspects of science education research (Olitsky, 2005, 2006). My research demonstrates that these constructs can be essential in helping researchers better understand what is happening in classrooms and schools. Research that better articulates

these constructs, making them more accessible to a wider group (beyond researchers) may have vast importance in helping teachers understand the link between communities and learning, between the affective and the cognitive (Collins, 2004).

As recently discussed by Yusko and Feiman-Nemser (2008) and supported by this research, traditional mentoring based on assessment or support seems to be ineffective for beginning science teachers. Although mentoring has been recognized as the most effective induction support program (Stockard & Lehman, 2004) this research illustrated that novice teachers' development might need a mentor teachers to generate and maintain a mentoring approach in which assessment and support are the concrete part of their service. More research is needed to understand how best to structure mentoring relationships and their potential effects.

APPENDIX A: SURVEYS

Science Teaching Efficacy Beliefs Instrument (STEBI)

(Riggs & Enochs, 1990)

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = Strongly Agree
A = Agree
UN = Unclear
D = Disagree
SD = Strongly Disagree

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.
SA A UN D SD
2. I am continually finding better ways to teach science.
SA A UN D SD
3. Even when I try very hard, I don't teach science as well as I do most subjects.
SA A UN D SD
4. When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.
SA A UN D SD
5. I know the steps necessary to teach science concepts effectively.
SA A UN D SD
6. I am not very effective in monitoring science experiments.
SA A UN D SD
7. If students are underachieving in science, it is most likely due to ineffective science teaching.
SA A UN D SD
8. I generally teach science ineffectively.
SA A UN D SD
9. The inadequacy of a student's science background can be overcome by good teaching.
SA A UN D SD
10. The low science achievement of some students cannot generally be blamed on their teachers.
SA A UN D SD
11. When a low science achieving child progress in science, it is usually due to extra attention given by the teacher.
SA A UN D SD
12. I understand science concepts well enough to be effective in teaching elementary science.
SA A UN D SD

13. Increased effort in science teaching produces little change in some students' science achievement.
SA A UN D SD
14. The teacher is generally responsible for the achievement of students in science.
SA A UN D SD
15. Students' achievement in science directly related to their teacher's effectiveness in science teaching.
SA A UN D SD
16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.
SA A UN D SD
17. I find it difficult to explain to students why science experiments work.
SA A UN D SD
18. I am typically able to answer students' science questions.
SA A UN D SD
19. I wonder if I have the necessary skills to teach science.
SA A UN D SD
20. Effectiveness in science teaching has little influence on the achievement of students with low motivation.
SA A UN D SD
21. Given a choice, I would not invite the principal to evaluate my science teaching.
SA A UN D SD
22. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.
SA A UN D SD
23. When teaching science, I usually welcome student questions.
SA A UN D SD
24. I don't know what to do to turn students on to science.
SA A UN D SD
25. Even teachers with good science teaching abilities cannot help some kids learn science.
SA A UN D SD

The Context Belief About Science Teaching (CBATS)

(Lumpe et al., 1990)

Environmental Factor	Column 1					Column 2				
	Following factors would enable me to be an effective teacher (SA = Strongly Agree A = Agree UN = Unclear D = Disagree SD = Strongly Disagree)					How likely is it that these factors will occur in your school? (VL = Very likely; SL = Somewhat Likely; N = Neither; SU = Somewhat Unlikely; VU = Very Unlikely)				
1. Professional staff development on teaching (workshops, conferences, etc.)	SA	A	UN	S	SD	VL	SL	N	SU	VU
2. State and national guidelines for science education (standards and goals)	SA	A	UN	S	SD	VL	SL	N	SU	VU
3. Support from other teachers (coaching, advice, mentoring, modeling, informal discussions, etc.)	SA	A	UN	S	SD	VL	SL	N	SU	VU
4. Team planning time with other teachers	SA	A	UN	S	SD	VL	SL	N	SU	VU
5. Hands-on science kits (activities and equipment)	SA	A	UN	S	SD	VL	SL	N	SU	VU
6. Community involvement (civic, business, etc.)	SA	A	UN	S	SD	VL	SL	N	SU	VU
7. Increased funding	SA	A	UN	S	SD	VL	SL	N	SU	VU
8. Extended class period length (e.g., block scheduling)	SA	A	UN	S	SD	VL	SL	N	SU	VU
9. Planning time	SA	A	UN	S	SD	VL	SL	N	SU	VU
10. Permanent science equipment (microscopes, glassware, etc.)	SA	A	UN	S	SD	VL	SL	N	SU	VU
11. Classroom physical environment (room size, proper furniture, sinks, etc.)	SA	A	UN	S	SD	VL	SL	N	SU	VU
12. Adoption of an official school science curriculum (goals, objectives, topics, etc.)	SA	A	UN	S	SD	VL	SL	N	SU	VU
13. Expendable science supplies (paper, chemicals)	SA	A	UN	S	SD	VL	SL	N	SU	VU

14. Support from administrators	SA A UN S SD	VL SL N SU VU
15. Science curriculum materials (textbooks, lab manuals, activity books, etc.)	SA A UN S SD	VL SL N SU VU
16. Technology (computers, software, Internet)	SA A UN S SD	VL SL N SU VU
17. Parental involvement	SA A UN S SD	VL SL N SU VU
18. An increase in students' academic abilities	SA A UN S SD	VL SL N SU VU
19. Involvement of the state board of education	SA A UN S SD	VL SL N SU VU
20. A decrease in your course teaching load	SA A UN S SD	VL SL N SU VU
21. A reduction in the amount of content you are required to teach	SA A UN S SD	VL SL N SU VU
22. Reduced class size (number of pupils)	SA A UN S SD	VL SL N SU VU
23. Involvement of scientists	SA A UN S SD	VL SL N SU VU
24. Involvement of university professors	SA A UN S SD	VL SL N SU VU
25. Classroom assessment strategies	SA A UN S SD	VL SL N SU VU
26. Teacher input and decision making	SA A UN S SD	VL SL N SU VU

APPENDIX B: OPEN-ENDED QUESTIONNAIRES

Self-Efficacy Questionnaire

Note: These questions are originated by Honey and Lumpe (1998).

1. What do you think it takes to be a good science teacher?
2. Describe how the physical environment in which you teach has either helped or hindered your science teaching.
3. Describe how people have either helped or hindered your science teaching.
4. Tell me about any positive or negative learning experiences you've had related to learning science.
5. Tell me about any positive or negative college course experiences you've had related to learning science.
6. Describe how well those classes prepared you to teach science.
7. Tell me about any positive or negative experiences you've had related to science during your adulthood.
8. Tell me about any positive or negative professional development experiences you've had related to learning science.
9. Do you think that you are capable of effective science teaching? Why or why not?
10. What are your strengths and weaknesses as a science teacher?
11. Is there anything else you would like to add regarding effective science teaching?

Pedagogical Discontentment Questionnaire

Note: These questions are developed by developed by Sowell et al. (in review).

1. Can you talk some about your past science experiences?
2. Depending on your preservice learning, are there any aspects of your teaching that you are not completely satisfied with?
3. Where (what context) have you been most satisfied with?
4. Where do you turn to for new information/solutions to teaching situations/problems that come up?
5. How would you know/recognize when something is successful/effective in your classroom? What signs would you look for?
6. How would you know/recognize when something is not successful/effective in your classroom? What signs would you look for?
7. How would you react to those signs?
8. Describe any constraints that you feel are preventing you from achieving your science teaching goals? (Allow for both external and internal)

APPENDIX C: INTERVIEW GUIDES

Science Teaching Philosophy Interview

Note: These questions are adjusted from the study of Smith (2000).

What do you remember about learning science during your elementary school years?

1. Describe any specific science lessons, units or activities that you remember.
2. Describe the way(s) that your teacher taught science.
3. How was your general feeling toward learning science?

What do you remember about learning science outside of school?

1. Describe any science-related experiences you experienced with your friends and family members (i.e., museums, zoos, gardening etc.)
2. What other types of exposure to science do you remember while growing up?

What do you remember about learning science during your junior high or high school years?

1. What science classes did you take?
2. Describe any specific science lessons, units or activities that you remember.
3. Describe the way(s) that your teacher taught science
4. Does any class/teacher stand out in your memory? Why?
5. How was your general feeling toward learning science?

Tell me about your teacher education program.

1. What was the reason to pursue a degree in education particularly in science education?
2. Describe your science methods course.
3. What was the content of the course?
4. How was the course taught (lecture, hands-on, activities, demonstration etc.)?
5. Were there any field components to the course?
6. Did you teach any course (to your peers or any grade level students)?
7. During your student teaching period, how was your cooperating teacher and university supervisor influence your learning to teach experiences?

What is the best way(s) to teach science?

1. How are you doing to teach science?
2. What is your motivation toward implementing your teaching goals?
3. What is your vision of students' science learning?
4. What is going to be your priority during your science lessons (students' learning, covering the content, preparation for standardized achievement tests etc.)?
5. What sort of expectations that you have from the school administration and other community members including other teachers, other beginning teachers, students, parents or your university professors?

Site Administrator Interview

Note: The structure of these questions is derived from Smith (2002).

What does it mean to teach science?

1. What is science?
2. What does doing science involve?
3. What is the role of experiment in science?
4. Why is it important to teach science?

What does the induction of beginning science teachers mean?

1. How would you describe “induction period” of a science teacher
2. What sorts of issues would you describe related to beginning science teachers transition to the teaching profession?
3. How does your school community including parents, students, and other teachers treat beginning science teacher?
4. Is there any difference between beginning science teachers and their counterparts in terms of their needs?
5. What does a beginning science teacher need in order to teach science effectively?

What is the principal’s role in supporting the beginning science teachers?

1. Describe your own emphasis or the importance that you place on supporting these beginning science teachers?
2. Is the performance that you expect from beginning science teachers the same as form experienced science teachers? Why/ Why not?
3. In what ways can a principal support beginning science teachers?
4. What sorts of support systems do you offer for beginning science teacher?
5. Describe the existing professional development and in-service activities to address beginning teachers, (if applicable) particularly beginning science teachers during their induction period.
6. How does the existing culture of your school enhance or inhibit the transition of beginning science teachers to teaching profession?

In your opinion does each of the following inhibit or support beginning science teachers’ experiences during their induction period?

1. State core curriculum
2. State and/or district testing policies and practices
3. Quality of available instructional materials
4. Access to technology for science subjects instructions
5. Fund for purchasing equipments and supplies for science instructions
6. Time available for beginning teachers to plan and prepare
7. Time available for beginning teachers to socialize and work with other teachers
8. Time and funds are available for beginning science teachers’ professional development

Teaching Philosophy Questionnaire

Note: These questions are originated by Settlage et al. (in review).

1. Briefly describe your student teaching experience.
2. What are your feelings about this experience? Do you feel successful? What accounts for this?
3. Think about individual subjects—what subject went particularly well? What accounts for this?
4. Was there a subject that went particularly badly? What accounts for this?
5. Let's focus on your science teaching. What was the focus of the science unit you wrote last fall? For approximately how many minutes have you actually taught science in your current classroom?
6. How successful do you feel in your science teaching? What are these feelings based upon? What accounts for your success (or lack thereof)? What would you change?
7. Were there students in your classroom that really seemed to benefit from your science instruction? Describe them. Were there students that didn't seem to benefit from your science instruction? Describe them.
8. Who were the most capable students (in terms of science) in your class? The most interested in science? Describe them.
9. Who were the students that were not particularly capable in terms of science? Who were not interested? Describe them. What accounts for this? Did you feel that you had any impact on the learning of these students? How?
10. What aspects of the teacher education program were particularly useful in helping you think about teaching science in diverse settings? Looking back on your cohort year, what additional support would you like to see?

Teacher Educator Interview

What are the goals of your program for future science educators?

What are the expectations of your program for future science educators?

1. What is the role of current reform efforts in the design and implementation of the undergraduate science education program?
2. Do you think your graduates have received enough preparation to implement reform-based science instruction?
3. How does the program prepare future science teachers to shift their practices toward reform suggestions and maintain their reform-based instructional practices? Do any of these efforts address the particular needs of novices during their induction period?
4. What are the issues embedded in teacher induction, and how does your program address these issues?
5. What is your programs emphasis on induction period of your graduates?
6. Are there any programs to support new teachers during their transition from preservice to the teaching profession?

APPENDIX D: OBSERVATION GUIDES

Observation Rubric: Physical Environment

Note: This rubric is developed by Smith (2000).

1. Description of science classroom resources including whether resources are sparse or rich.

2. Description of classroom space including whether the space is adequate or crowded.

3. Description of the classroom arrangement, including whether the arrangement inhibited or facilitated the interactions between teacher and students and among the students.

Observation Rubric

Note: This observation rubric is adjusted from Smith (2000).

1. The major content are(s) of this lesson or activity:
Biology (Topic.....)
Chemistry (Topic.....)
Physics (Topic.....)
Anatomy and Physiology (Topic.....)
Astronomy (Topic.....)
Earth Space Science (Topic.....)
Marine Science (Topic.....)
None of the above (Explain.....)
2. Description of the lesson:
3. The major teaching strategy(s) in which student activities are structured:
Whole group
Small groups (How groups are assigned:.....)
Pairs (How assigned.....)
Individuals
Description of the activities:

4. Major approach(s) in which students engaged in the activities:
Entire class is engaged in the same activities at the same time
Groups of students engage in the different activities at the same time
Describe the activities:

5. Major activities of students in this lesson

Listening to presentation

- By teacher (includes demonstrations, lectures, media presentations, instruction)
- By students (includes informal as well as formal presentations of their work)
- By guest speaker/expert serving as a resource

Engaging in discussion seminar

- Whole group
- Small groups/pair

Being engaged in problem solving/investigation

- Working with manipulative
- Playing a game to build or review knowledge/skills
- Following specific instructions in an investigation
- Having some latitude in designing an investigation
- Recording, representing and/or analyzing data
- Recognizing patterns cycles of trends
- Evaluating the validity of arguments and claims
- Providing informal justification of formal evidence
- Assessing a process

Being engaged in reading/reflection/written communication about science

- Reading about science
- Answering textbook/worksheets questions
- Reflecting on readings, activities or problems individually or in groups
- Preparing a written report
- Writing a description of a plan, procedure or problem solving process

- Writing reflections in a notebook or journal

Using technology/audiovisual resource

- To develop conceptual understanding
- To learn or practice a skill
- To collect data
- As a presentation tool
- For word processing or communication tool

Other activities integrated into the science lesson

- Mathematics activity
- Arts and crafts activity
- Listening to a story
- Writing a poem or story
- Other (Describe:.....)

What seems to be the emphasis of the lesson? What is stressed? (May include)

- Completing the activity
- Understanding the content
- Classroom management
- Integration with other disciplines
- Learning science process or skills
- Understanding the nature of science
- Stimulating the interest or enthusiasm fro science

**APPENDIX E: HUMAN SUBJECT COMMITTEE APPROVAL AND CONSENT
FORMS**

Human Subject Committee
Letter of Consent for Adults

"What happens to our reform-minded beginning secondary science teachers during their induction period?"

I have been informed that:

1. Yavuz Saka, a graduate student under the direction of Dr. Sherry Southerland in the Science Education Program, Department of Middle and Secondary Education, at Florida State University, has requested my participation in a research study of my school where his research subject is teaching under my direction during 2005-2006 school year.
2. The purpose of this research is to better understand the change in beginning science teachers' sense of self-efficacies and pedagogical discontentment during these beginning science teachers induction period. It is also his purpose to acknowledge the influential factors over these changes.
3. My participation will involve discussing personal beliefs and practices during interviews. I understand that my participation is voluntary during the 2005-2006 school year, and if I choose not to participate or to withdraw from the study at any time, there will be no penalty.
4. There are no foreseeable risks or discomforts if I agree to participate in this study.
5. The results of this research study may be published but my name or identity will not be revealed. The researcher will do the following to maintain confidentiality of my records, to the extent allowed by law. I understand that I will be tape recorded by the researcher and that these tapes will be kept by the researcher in a locked filing cabinet. I understand that only the researcher will have access to these tapes and that they will be destroyed by October 1, 2012.
6. I will not be paid for my participation. Although there may not be any direct benefits to me, the possible benefits for participating in this study are an increased awareness of my personal learning behaviors.
7. Any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by Yavuz Saka at (850) 877 98 17 Carothers Hall, Florida State University, yys3536@garnet.acns.fsu.edu., or by Dr. Sherry Southerland, his major professor, at 645-4667 or southerl@coe.fsu.edu.
8. If I have questions about my rights as a subject/participant in this research, or if I feel I have been placed at risk, I can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Office of the Vice President for Research, at (850) 644-8633.

Human Subject Committee
Letter of Consent for Adults

"What happens to our reform-minded beginning secondary science teachers during their induction period?"

I have read the above informed consent form. I understand that information obtained during the course of the study will remain confidential, to the extent allowed by law. I understand that I will be tape recorded by the researcher and that these tapes will be kept in a locked filing cabinet. I understand that only the researcher will have access to these tapes and that they will be destroyed by October 1, 2012.

I understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefits to which I may otherwise be entitled. In signing this consent form, I am not waiving any legal claims, rights or remedies. A copy of this consent form will be offered to me.

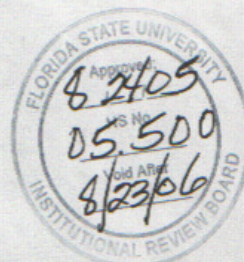
Sincerely,

Participant's Signature

[Redacted Signature]

Date

[Redacted Date]



APPENDIX F: SCHOOL DISTRICT APPROVAL

SCHOL DISTRICT APPROVAL

Supporting documentation withheld for purposes of confidentiality.

Please direct any questions or concerns to:
Dr. Sherry A. Southerland, Associate Professor
Florida State University
College of Education
Carothers Building
Tallahassee, Florida 32306
southerl@coe.fsu.edu
(850)644-4667

REFERENCES

- Abell, S. K. (2000). From professor to colleague: Creating a professional identity as collaborator in elementary science. *Journal of Research in Science Teaching* 37, 548-62.
- Abrams E., Southerland, S. and Evans, C. A. (in press). *Inquiry in the Classroom: Identifying Necessary Components of a Useful Definition*
- Achinstein, B., Ogawa, R., and Speiglman, A. (2004). Are we creating separate and unequal tracks of teachers? The effects of state policy, local conditions, and teacher characteristics on new teacher socialization. *American Educational Research Journal*, 41(3), 557-599.
- Adams, P. E., & Krockover, G. H. (1997). Beginning science teacher cognition and its origins in the preservice secondary science teacher program. *Journal of Research in Science Teaching*, 34(6), 633-653.
- Akerson, V.L., Morrison, J.A., & McDuffie, A. Roth. (2006). One course is not enough: preservice teachers' retention of improved views of nature of science. *Journal of Research in Science Teaching*, 43(2), 194-213.
- Allinder, R. M. (1995). An examination of the relationship between teacher efficacy and curriculum-based measurement and student achievement. *Remedial and Special Education*, 16(4), 247-54.
- American Association for the Advancement of Science (AAAS) (1989). Project 2061: *Science for all Americans: A Project 2061 report on literacy goals in science, mathematics, and technology*. Washington, D.C.: AAAS.
- American Association for the Advancement of Science (AAAS) (1993). *Benchmarks for science literacy*. New York: Oxford University Press.
- Andersen A. M., Dragsted, S., Evans, R. H., & Sorensen, H. (2004). The relationship between changes in teachers' self-efficacy beliefs and the science teaching

- environment of Danish first year elementary teachers. *Journal of Science Teacher Education*, 15(1), 25-38.
- Anderson, C. W. (2002). *Learning to teach science for understanding*. East Lansing, Michigan State University.
- Anderson, R., & Mitchener, C. (1994). Research on science teacher education. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 3-44). New York: Macmillan.
- Atkinson, E. S. (1994). Key factors which affect pupils' performance in technology project work. In J. S. Smith (Ed.), IDATER 94, Loughborough: *Design and technology*, (pp. 30-37). Loughborough University.
- Ball, S. (1994). *Education reform: A critical and post-structural approach*. Milton Keynes: Open University Press.
- Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychology Review*, 84, 191-215.
- Bandura, A. (1986). *Social foundations of thought and action*. Engelwood Cliffs, NJ: Prentice-Hall.
- Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, 44 (9), 1175-1184.
- Bandura, A. (1995). *Self-efficacy in changing societies*. New York: Cambridge University Press.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
- Bandura A. (2000a). Self-efficacy: the foundation of agency. *Control of Human Behavior, Mental Processes, and Consciousness*, 17-33.
- Bandura, A. (2000b). Exercise of human agency through collective efficacy. *Current Directions in Psychological Science*, 9, 75-78
- Baptiste, N., & Sheerer, M. (1997). Negotiating the challenges of the "survival" stage of professional development. *Early Childhood Education Journal*, 24(4), 265-267.
- Becker, Howard S. 1998. *Tricks of the Trade: How to think about your research while you're doing it*. Chicago: University of Chicago Press.
- Bell, J. (2001). *Doing your research project*. Buckingham, Open University Press.

- Berliner, D. C. (1992). *Educational reform in an era of disinformation*. Paper presented at the meeting of the American Association of Colleges for Teacher Education, San Antonio, Texas, February. ERIC: ED 348 710.
- Berliner, D. C. (2006). Our impoverished view of educational research. *Teachers College Record*, 108(6), 949-995.
- Bernstein, B. (1990). *The structuring of pedagogic discourse*. London: Routledge.
- Bianchini, J.A., & Cavazos, L.M. (2007). Learning from students, inquiry into practice, and participation in professional communities: Beginning teachers' uneven progress toward equitable science teaching. *Journal for Research in Science Teaching*, 44(4), 586-612.
- Blair-Larsen, S. M., & Bercik, J. T. (1990). *A collaborative model for teacher induction*. (ERIC Document, ED 341 642).
- Blake, R. W. (2002). *An enactment of science*. New York: Peter Lang.
- Blanchard, M.R. (2006). *Assimilation or transformation? An analysis of change in secondary science teachers following an inquiry-based field experience*. Unpublished doctoral dissertation, Florida State University, Tallahassee, FL.
- Blase, J. & Blase, J (2004). The dark side of school leadership: Implications for administrator preparation. *Leadership and Policy in Schools*, 13, 4, 245–273.
- Bleicher, R. E. (2004). Revisiting the STEBI-B: Measuring self-efficacy in preservice elementary teachers. *School Science and Mathematics Journal*, 104, 383–391.
- Bloom, L.R. (1998). *Under the sign of hope. Feminist methodology and narrative interpretation*. Albany, State University of New York Press.
- Bloomer, M. & Hodkinson, P. (2000) Learning careers: Continuity and change in young people's dispositions to learning. *British Educational Research Journal*, 26 (5), 583-598.
- Bogdan, C. R. & Biklen, K. S. (1998). *Qualitativ research for education. An introduction to theory and methods*. Third Edition. Ally & Bacon, Needham Heights, MA.
- Borich, G. (1999). *Effective teaching methods* (4th ed.). Columbus, OH: Merrill/Prentice Hall.
- Brabdoli, A. & Andrew Y. (2001). *"Remaking Identities."* A multi-media presentation. Beyond Hope Conference: Constructing B.C. History, B.C. Studies Conference, University College of the Cariboo.

- Brickhouse, N.W., Lowery, P., & Schultz, K. (2000). What kind of a girl does science? The construction of school science identities. *Journal for Research in Science Teaching*, 37(5), 421 – 458.
- Brickhouse, N. W. & Potter, J. T., (2001). Young women's scientific identity formation in an urban context. *Journal of Research in Science Teaching*, 38(8) 965-980
- Brock, B., & Grady, M. (1997). Principals: The guiding light for new teachers. *Momentum*, 28(2), 52-55.
- Brockmeyer, M. (1998). *The impact of an extended inquiry-based in-service program on the beliefs and practices of beginning secondary science teachers*. Unpublished dissertation. Iowa City: University of Iowa Press.
- Brooks, J. (2006). *The dark side of school reform: Teaching in the space between reality and utopia*. Rowman & Littlefield Education.
- Bruner, J. (1999). Postscript: Some reflections on education research. In E. C. Lagemann & L. S. Shulman (Eds.), *Issues in education research* (pp. 399-409). San Francisco: Jossey-Bass Publishers.
- BSCS (1994). *Innovations in science education survey instrument*. Colorado, Springs, CO: Author.
- Bullough, R. (1989). *First-year teacher: A case study*. New York: Teachers College.
- Bullough, R. (1992) Beginning teacher curriculum decision making: Personal teaching metaphors, and teacher education. *Teaching and Teacher Education*, 8(3), 239-252.
- Bullough, R. V., Knowles, J. G., & Crow, N. A. (1992). *Emerging as a teacher*. London: Routledge.
- Burley, W. W., Hall, B. W., Villeme, M. G., & Brockmeier, L. L. (1991). *A path analysis of the mediating role of efficacy in first-year teachers' experiences, reactions, and plans*. Paper presented at the annual meeting of the American Education Research Association, Chicago, IL.
- Bybee, R.W. (1993). *Reforming science education. Social perspectives and personal reflections*. NY: Teachers College Press.
- Carlone, H.B., Webb, S.M. (2006). On (not) overcoming our history of hierarchy: Complexities of university/school collaboration. *Science Education*, 90 (3), 544-568.

- Carter, K., & Doyle, W. (1987). Teachers knowledge structures and comprehension processes. In J. Calderhead (Ed.), *Exploring teachers' thinking*. London: Cassell Educational.
- Century Foundation (2000). *Expanding the supply of quality teachers*. Century Foundation.
- Clandinin, J. D., & Connelly, F. M. (2000). *Narrative inquiry*. San Francisco, CA: Jossey-Bass Inc.
- Claxton G (2002). *Building learning power: helping Young people become better learners*. Bristol: TLO.
- Cobb, P. & Bowers, J. (1999). Cognitive and situated learning perspectives in theory and practice. *Educational Researcher*, 28(2), 5-15.
- Coble, C. & Koballa, T. (1996). Science Education. In *Handbook of research on teacher Education*, second edition, J. Sikula, T. J. Buttery, & E. Guyton (Eds.), (pp. 459-484). New York: Macmillan.
- Coffey, A. & Atkinson, P. (1996). *Making sense of qualitative data: Complementary research strategies*. Thousand Oaks, CA: Sage
- Cole, M. (2001). Sustaining model systems of educational activity: Designing for the long haul. Paper presented at the Symposium Honoring the Work of Ann Brown, University of California, Berkeley.
- Cole, M., and Engestrom, Y. (1993). A cultural-historical approach to distributed cognition. In Gavriel Salomon (Ed.). *Distributed cognitions: Psychological and educational considerations*. NY: Cambridge University Press.
- Cole, T. R. (1993). The prophecy of senescence: G. Stanley Hall and the reconstruction of old age in twentieth century America. In W. K. Schaie & W. A. Achenbaum (Eds.), *Societal impact on aging: Historical perspectives* (pp. 165-181). New York: Springer.
- Collins, R. (2004). *Interaction ritual chains*. Princeton, NJ: Princeton University Press.
- Costa, V. (1997). How teacher and students study 'all that matters' in high school chemistry. *International Journal of Science Education*, 19, 1005-1023.
- Cranny, C. J., Smith, P. C. & Stone, E. F. (1992). *Job satisfaction: How people feel about their jobs and how it affects their performance*. Lexington Books: New York.
- Creswell, J. (1994). *Research design: Qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.

- Crossan, F. (2003). Research philosophy: towards an understanding. *Nurse Researcher*, 11 (1), 46-55.
- Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. London: Sage.
- Cuban, L. (1990). Reforming again, again and again. *Educational Researcher*, 19(1), 3-13.
- Czerniak, C. (1990). Teacher education for effective science instruction: A social cognitive perspective. *Journal of Teacher Education*, 41(1), 49-58.
- Czerniak, C. M., & Lumpe, A. T. (1996). Relationship between teacher beliefs and science education reform. *Journal of Science Teacher Education*, 7, 247-266.
- Dagenais, R. (1996). *Mentoring program standards*. (ERIC document, ED 419 776).
- Danielewicz, J. (2001). *Teaching selves*. State University of New York. U.S.A.
- Darling-Hammond, L. (1997). *The right to learn: A blueprint for creating schools that work*. San Francisco, CA: Jossey Bass.
- Darling-Hammond, L. (1998). Teachers and teaching: Testing policy hypotheses from a national commission report. *Educational Researcher*, 27(1) 5-15.
- Darling-Hammond, L., Wise, A. F., & Klein, S. P. (1999). *A license to teach: Raising standards for teaching*. San Francisco: Jossey-Bass.
- Darling-Hammond, L. (2000). Solving the dilemmas of teacher supply, demand, and standards: how we can ensure a competent, caring, and qualified teacher for every child. [Online}. Available: <http://www.tc.edu/nctaf/publications/solving.html> [February 26, 2005]
- Darling-Hammond, L., & Sclan, E. M. (1996). Who teaches and why. Dilemmas of building a profession for twenty-first century schools. In *Handbook of research on teacher education*, second edition, J. Sikula, T. J. Buttery, & E. Guyton (Eds.), (pp. 67-101). New York: Macmillan.
- Darling-Hammond, L., & Sykes, G. (2003). Wanted: A national teacher supply policy for education: The right way to meet the “highly qualified teacher” challenge. *Education policy analysis archives*, 11(33). [Online}. Available: <http://epaa.asu.edu/epaa/v11n33/> [February 26, 2005]

- Davydov, V. (1999). The content and unsolved problems of activity theory. In Y. Engeström, R. Miettinen & R.-L. Punamääki (Eds.), *Perspectives on activity theory* (pp. 39--52): Cambridge University Press.
- del Rio, P., & Alvarez, A. (2002). From activity to directivity: The question of involvement in education. In G. Well & G. Claxton (Eds.), *Learning for life in the 21st century: Sociocultural perspectives on the future of education* (pp. 59-72). Oxford: Blackwell. 59-72.
- Donato, R. (2004). Aspects of collaboration in pedagogical discourse. *Annual Review of Applied Linguistics*, 24, 284-302
- Driver, R., Squires, A., Rushworth, P., & Wood-Robinson, V. (1994). *Making sense of secondary science: Research into children's ideas*. New York: Routledge.
- Eick, C. & Dias, M. (2005). Building the authority of experience through coteaching: Studying methods students' thinking on practice in inquiry classrooms. *Science Education*, 89 (3), 470-491.
- Eick, C. & Reed, C. (2002). What makes an inquiry-oriented science teacher? The influence of learning histories on student teacher role identity and practice. *Science Education*, 86, 401-416.
- Eisner, E.W. 1993. Forms of understanding and the future of educational research. *Educational Researcher*, 22 (7), 5-11.
- Elmore, R. (2003). Bridging the gap between standards and achievement: The imperative for professional development in education. [Online}. Available: http://www.ashankerist.org/Downloads/Bridging_Gap.pdf. [February 26, 2005]
- Emerson, R.M., Fretz, R.I. & Shaw, L.L. (1995). *Writing ethnographic fieldnotes*. Chicago & London: University of Chicago Press.
- Emmer, D. T. (1986). Academic activities and tasks in first year teachers' classes. *Teaching and Teacher Education*, 42, 386-399.
- Engeström, Y. (1987) *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki: Orienta-Konsultit.
- Engeström, Y. (1994). *Training for change: new approach to instruction and learning in working life*. Geneva: International Labour Office.
- Engeström, Y. (1999). Activity theory and individual and social transformation. Perspectives on activity theory. In J. Engeström, R. Miettinen, & R. Punamaki (Eds). *Perspectives on activity theory: Learning in doing: Social, cognitive and computational perspectives* (pp. 19-38). Cambridge Press, The Edinburgh Building, Cambridge

- Engeström, Y. (2001) Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work*, 14(1), 133-156.
- Engeström, Y. & Cole, M. (1993). A cultural-historical approach to distributed cognition, in Soloman, G (ed) *Distributed cognition*. Cambridge, Cambridge University Press.
- Engeström, Y., Engeström, R., Kärkkäinen, M. (1995). Polycontextuality and boundary crossing in expert cognition: learning and problem solving in complex work activities. *Learning and Instruction*, 5.
- Engeström, Y., and Escalante, V. (1996): 'Mundane Tool or Object of Affection? The Rise and Fall of the Postal Buddy', in B. A. Nardi (ed.): *Context and consciousness: Activity theory and human-computer interaction*, MIT Press, Cambridge, Massachusetts, and London, England, pp. 325-373.
- Engeström, Y., & Miettinen, R. (1999). Introduction. In Y. Engeström & R. Miettinen & R. Punamaki (Eds.), *Perspectives on activity theory* (pp 1-16). Cambridge, UK: Cambridge University Press.
- Enyedy, N., Goldberg, J., & Welsh, K.M. (2006). Complex dilemmas of identity and practice. *Science Education*, 90 (1), 68-93.
- Evans, L. (1997). Addressing problems of conceptualization and construct validity in researching teachers' job satisfaction. *Educational Research*, 39(3), 319-331.
- Feiman-Nemser, S (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record*, 103(6), 1013-1055.
- Feiman-Nemser, S. (2003). What new teachers need to learn. *Educational Leadership*, 60, 25-29.
- Feldman, A. (1997). Varieties of wisdom in the practice of teachers. *Teaching and Teacher Education*, 13(7), 757-773.
- Feldman, A. (2000). Decision making in the practical domain: A model of practical conceptual change. *Science Education*, 84(5), 606-623.
- Feldman, A. (2002). Existential approaches in action research. *Educational Action Research*, 10(2), 233-252.
- Fetters, M.K., Czerniak, C.M., Fish, L., & Shawberry, J. (2002). Confronting challenging, and changing teachers' beliefs: Implications from a local systemic change professional development program. *Journal of Science Teacher Education*, 12(2), 101-130.

- Foot, K.A. (2001). Cultural-Historical Activity Theory as practical theory: Illuminating the development of a conflict monitoring network. *Communication Theory*, 11, 56–83.
- Ford, M. E. (1992). *Motivating humans: Goals, emotions, and personal agency beliefs*. Newbury Park, CA: Sage.
- Forte, I., & Schurr, S. (2002). *The definitive middle school guide: A handbook for success* (Rev. Ed.). Nashville, Tenn.: Incentive Publications.
- Fraenkel, R. J. & Wallen, E. N. (1996). *How to design and evaluate research in education*. Third Edition. Von Hoffmann Press.
- Frese, M. & Sabini, J. (1985). Action theory: and introduction in Frese, M. & Sabini, J. (Eds.) *Goal Directed Behavior: The Concept of Action in Psychology*, Hillsdale, New-Jersey: Lawrence Erlbaum Ass., Pub.
- Friedrichsen, P., Munford, D., & Orgill, M.K. (2006). Brokering at the boundary: A prospective teacher engages students in inquiry. *Science Education*, 90(4), 522-543.
- Friedman, I.A. (1996). Multiple pathways to burnout: Cognitive and emotional scenarios in teacher burnout. *Anxiety, Stress, and Coping*, 9, 245–259.
- Friedman, I. A. (2000). Burnout in teachers: Shattered dreams of impeccable professional performance. *Journal of Clinical Psychology*, 56(5), 595-606.
- Fuller, F. F. (1969). Concerns about teachers: A developmental conceptualization. *American Educational Research Journal*, 6(2), 207-226.
- Gall, M.D., Borg, W.R., & Gall, J.P. (1996). *Educational research* (6th ed.). White Plains: Longman.
- Gallagher, J. J. (1991). Prospective and practicing secondary school science teacher knowledge and beliefs about the philosophy of science. *Science Education*, 75, 121-133.
- Gandal, M., & Vranek, J. (2001). Standards: Here today, here tomorrow. *Educational Leadership*, 59 (1), 6-13.
- Ganser, T. (1996). Mentor roles: Views of participants in a state-mandated program. *Mid-Western Educational Researcher*, 9(2), 15-20.
- Gee, J. P. (2001). Identity as an analytic lens for research in education. In W.G. Secada, Ed., *Review of Research in Education* 25. Washington DC: American Educational Research Association.

- Gess-Newsome, J., Southerland, S. A., Johnston, A., & Woodbury, S. (2003). Educational reform, personal practical theories, and dissatisfaction: The anatomy of change in college science teaching. *American Educational Research Journal*, 40 (3), 731-767.
- Giddens, A. (1984). *The constitution of society: Outline of the theory of structuration*. Cambridge: Polity Press.
- Giddens, A. (1991). *Modernity and self-identity: Self and society in the late modern age*. Stanford: Stanford University Press.
- Glaser, B. (1978). *Theoretical sensitivity: Advances in the methodology of grounded theory*. Mill Valley, CA: Sociology Press.
- Gold, Y. (1996). Beginning teacher support. Attrition, mentoring, and induction. In C. B. Courtney (Ed.) *Review of research in education*, 16, (pp. 548-594). Washington, DC: American Educational Research Association.
- Goodson, I. F. & Mangan, J. M. (1991). An alternative paradigm for educational research. In I. F., Goodson, & J. M. Mangan (Eds.). *Qualitative educational research studies: Methodologies in transition*. (Occasional Paper No. 1) (pp. 9-48) London, Canada: Research Unit on Classroom Learning and Computer Use in Schools, University of Western Ontario.
- Grant, L.L (2004). Meta-analysis of induction and mentoring programs' contribution to new teacher retention during the first five years of employment. *Dissertation Abstracts International*, 64(12), 4287.
- Gratch, A. (2001). The culture of teaching and beginning teacher development. *Teacher Education Quarterly*, 28(4), 121-136.
- Greenwald, R., Hedges, L., & Laine, R. (1996). The effect of school resources on student achievement. *Review of Educational Research*, 66(3), 361-396.
- Gregoire, M. (2003). Is it a challenge or a threat? A dual-process model of teachers' cognition and appraisal processes during conceptual change: *Educational Psychology Review*, 15, 147-179.
- Griffin, G. A. (1985). Teacher induction: Research issues. *Journal of Teacher Education*, 36(1), 42-46.
- Grossman, P., Thompson, C., & Valencia, S. (2002). Focusing the concerns of new teachers: The district as teacher educator. In A. Hightower, M. S. Knapp, J. A. Marsh, & M. W. McLaughlin (Eds.), *School districts and instructional renewal* (pp. 129-142). New York, NY: Teachers College Press.

- Grundy, S. (1987). *Curriculum: Product or praxis*. The Folmer press, NY.
- Guba, E., & Lincoln, Y. (1989). *Fourth generation evaluation*. Beverly Hills, CA.
- Guillaume, A.M., & Rudney, G.L. (1993). Student teacher's growth toward independence: An analysis of their changing concerns. *Teaching and Teacher Education*, 9, 65-80.
- Guskey, T. R. (1984). The influence of change in instructional effectiveness upon the affective characteristics of teachers. *American Educational Research Journal*, 21, 245-259.
- Guskey, T. R. (1998). The age of our accountability. *Journal of Staff Development*, 19(4), 36-44.
- Guskey, T. R., & Passaro, P. D. (1994). Teacher efficacy: A study of construct dimensions. *American Educational Research Journal*, 31(3), 627-643.
- Haberman, M. (1991). The pedagogy of poverty versus good teaching. *Phi Delta Kappan*, 73(4), 290-294.
- Haney, J. & Lumpe, A. T. (1998). *Profiling the personal agency belief patterns of K-12 science teachers*. A paper presentation at the Annual Meeting of the National Association of Research in Science Teaching, San Diego, CA.
- Haney, J. J., Lumpe, A. T., & Czerniak, C. M. (2002). From beliefs to actions: The beliefs and actions of teachers implementing change. *Journal of Science Teacher Education*, 13, 171-187.
- Hasan, H. (2002). Information systems as dialectic, tool-mediated activity. *Australian Journal of Information Systems*, Special Issue, 30-39.
- Hasan, R. (1996). Semantic networks: A tool for the analysis of meaning', in C. Cloran, D. Butt and G. Williams (Eds.) *Ways of Saying: Ways of Meaning. Selected papers of Ruqaiya Hasan* (pp. 104-131). London: Cassell.
- Helms, J. (1998). Science-and me: Subject matter and identity in secondary school science teachers. *Journal of Research in Science Teaching*, 35(7), 811-834.
- Hodkinson, H. & Hodkinson, P. (2005) Improving schoolteachers' workplace learning. *Research Papers in Education*, 20(2) 109-131.
- Holland, D., Lachicotte, W., Jr., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds*. Cambridge, MA: Harvard University Press.

- Holmes Group (1986). *Tomorrow's teachers: A report of the Holmes Group*. East Lansing, MI: Author.
- Huffman, J., Assaf, L., & Paris, S. (2001). High-stakes testing in reading: Today in Texas, tomorrow? *The Reading Teacher*, 54, 482-492.
- Hughes, J. (1994). *The philosophy of social research*. Essex, Longman.
- Hughes, L. (1999). *The principal as leader*. Upper Saddle River, NJ: Prentice Hall.
- Huling-Austin, L. (1989). Beginning teacher programs: An overview. In Huling-Austin, L., Odell, S. J., Ishler, P., Kay, R. S., & Edelfelt, R. A. (Ed.), *Assisting the beginning teachers*, (p. 5-18). Reston, VA: Association of Teacher Educators.
- Huling-Austin, L. (1990). Teacher induction program and internships. In D. M., Brooks (Ed.), *Teacher induction: A new beginning* (pp. 3-19). Reston, VA: Association of teacher Educators.
- Huling-Austin, L. (1992). Research on learning to teach: Implications for teacher induction and mentoring programs. *Journal of Teacher Education*, 43(3), 173-180.
- Huntley, M.A., Britton, E., Raizen, S. & Paine, L. (n/d). More swimming, less sinking: Perspectives on teacher induction in the U.S. and abroad. Paper presented at a meeting of the National Commission on Teaching Mathematics and Science in the 21st Century.
- Imig D. G. & Imig S.R. (2006). What do beginning teachers need to know? *Journal of Teacher Education*, 57(3), 286-291.
- Ingersoll, R.M. (1999). The Problem of Underqualified Teachers in American Secondary Schools. *Educational Researcher*, 28(2), 26-37.
- Ingersoll, R. M. (2001). Teacher turnover and teacher shortages: An organizational analysis. *American Educational Research Journal*, 37(3), 499-534.
- Ingersoll, R. M. (2002). The teacher shortage: A case of wrong diagnosis and wrong prescription. *NASSP Bulletin*, 86(631), 16-30.
- Ingersoll, R.M., & Kralik, J.M. (2004). The impact of mentoring on teacher retention: What the research says. *ECS Research Review*, Denver, CO: Educational Commission of the States.
- Ingersoll, R. M. & Smith, T. (2003). The wrong solutions to the teacher shortage. Loss of new teachers plays a major role in the teacher shortage, but pouring more teachers

- into the system will not solve the retention problem. *Educational Leadership*, 60 (8), 30-33.
- Jerald, C. D., & Boser, U. (2000). Setting policies for new teachers. *Education Week*, 19(18), 44-45, 47.
- Johnson, S.M. (2001). Can professional certification for teachers reshape teaching as a career? *Phi Delta Kappan*, 82 (5): 393–399.
- Kagan, D. (1992). Professional growth among preservice teachers. *Review of Educational Research*, 62(2), 129-169.
- Kärkkäinen, M. (1999), *Teams as Breakers of Traditional Work Practices: A Longitudinal Study of Planning and Implementing Curriculum Units in Elementary School Teacher Teams*, Department of Education, University of Helsinki, Helsinki, Vol. Research Bulletin 100.
- Kauffman, D., Johnson, S. M., Kardos, S. M., Liu, E., & Peske, H. G. (2002). "Lost at sea": New teachers' experiences with curriculum and assessment. *Teachers College Record*, 104(2), 273-300.
- Kerr, S. (1997). Why Vygotsky? The role of theoretical psychology in Russian Education reform. Presented at the annual meeting of the American association for the advancement of Slavic studies. Seattle, Washington November 22, 1997.
- Klepper, N. H., & Barufaldi, J. P. (1998). *The induction years: Pathways and barriers to effective practice for the middle school science teacher*. (ERIC Document No. 418 867).
- Kozoll, R. H. & Osborne, M.D. (2004). Finding meaning in science: Lifeworld, identity, and self. *Science Education*, 88(2) 157-181.
- Kuutti, K. (1999). Activity theory, transformation of work, and information systems design. In J. Engestrom, R. Miettinen, & R. Punamaki (Eds). *Perspectives on activity theory: Learning in doing: Social, cognitive and computational perspectives* (pp. 360-376). Cambridge Press, The Edinburgh Building, Cambridge.
- Kyriacou, C. (1989). Teacher stress and burnout: an international review. *Educational Research*, 29, 146-152.
- Latt, J. & Watters, J.J. (1995). Science teaching self-efficacy in a elementary school: A case study. *Research in Science Education*, 25(4), 453-464.
- Lave, J. & E. Wegner (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.

- Lawson, A.E. (2005). What is the role of induction and deduction in reasoning and scientific inquiry? *Journal of Research in Science Teaching*, 42 (6), 716-40.
- Lawson, H. A. (1991). Three perspectives on induction and a normative order for physical education. *Quest*, 43, 20-36.
- Lawson, H. A. (1992). Beyond the new conception of teacher induction. *Journal of Teacher Education*, 43(3), 163-172.
- Lederman, N.G., & Gess-Newsome, J. (1991). Metamorphosis, adaptation, or evolution?: Preservice science teachers' concerns and perceptions of teaching and planning. *Science Education*, 75(4), 443-456.
- Leiman, M. (1999). The concept of sign in the work of Vygotsky, Winnicott, and Bakhtin: Further integration of object relations theory and activity theory. . In J. Engestrom, R. Miettinen, & R. Punamaki (Eds). *Perspectives on activity theory: Learning in doing: Social, cognitive and computational perspectives* (pp. 419-434). Cambridge Press, The Edinburgh Building, Cambridge.
- Lemke, J. L. (1994). *The missing context in scienceeEducation: Science*. Paper presented at American Educational Research Association annual meeting, Atlanta, GA (April (1992). Arlington VA: ERIC Documents Service (ED 363 511).
- Lemke, J.L. (2002). Becoming the village: Education across lives. In G. Wells and G. Claxton, Eds. *Learning for Life in the 21st century: Sociocultural perspectives on the future of education*. London: Blackwell. pp. 34-45.
- Leont'ev, A. N. (1978). *Activity, consciousness, and personality*. Englewood Cliffs: Prentice Hall.
- Levitt, K. (2001). An analysis of elementary teachers' beliefs regarding the teaching and learning of science. *Science Education*, 86, 1-22.
- Liston D., Whitcomb J. & Borko, H. (2006). Too little or too much: Teacher preparation and the first years of teaching. *Journal of Teacher Education*, 57(4), 351-358.
- Little, J. W. (1990). The mentoring phenomenon and the social organization of teaching: *Review of research in education* 16, 297-351. Washington, DC: American Educational Research Association.
- Loughran, J. J. (1994) Bridging the gap: an analysis of the needs of second year science teachers. *Science Education*, 78(4), 365-86.
- Luft, J.A. (2007). Minding the gap: Needed research on beginning/newly qualified science teachers. *Journal of Research in Science Teaching*, 44(4), 532-537.

- Luft, J.A., & Cox, W.E. (2001). Investing in our future: A survey of support offered to beginning secondary science and mathematics teachers. *Science Educator*, 10(1) 1-9.
- Luft, J. A., & Patterson, N. C. (1999). *Final report: Project: Alternative support for induction science teachers (ASIST)*. Phoenix, AZ: Arizona Board of Regents: Eisenhower Mathematics and Science Program.
- Luft, J. A., & Patterson, N. C. (2002). Bridging the gap: Supporting beginning science teachers. *Journal of Science Teacher Education*, 13(4), 267-282.
- Luft, J.A., Roehrig, G.H., & Patterson, A.C. (2003). Contrasting landscapes: A comparison of the impact of different induction programs on beginning secondary science teachers' practices and beliefs. *Journal of Research in Science Teaching*, 40(1), 77-97.
- Lumpe, A. T., Haney, J. J., & Czerniak, C. M. (2000). Assessing teacher's beliefs about their science teaching context. *Journal of Research in Science Teaching*, 37, 275-292.
- Mahn, H., & John-Steiner, V. (2002). The gift of confidence: A Vygotskian view of emotions. In G. Wells & G. Claxton (Eds.), *Learning for life in the 21st century: Sociocultural perspectives on the future of education*. Oxford: Blackwell.
- Marsh, J. (2002). How districts relate to states, schools, and communities: A review of emerging literature. In A. Hightower, M. Knapp, J. Marsh, & M. McLaughlin (Eds.), *School districts and instructional renewal: Opening the conversation*, (pp. 25-41). New York: Teachers College.
- Marshall, C. & Rossman, G. B. (1989). *Designing qualitative research*. California: Sage.
- Marx, K. (1976). *Capital*. Translated by Ben Fowkes. 3 vols. New York: Penguin Press.
- Marzano, R. J., Waters, T., & McNulty, B. A. (2005). *School leadership that works: From research to results*. Alexandria, VA: Association for Supervision & Curriculum Development.
- Maxwell, J. A. (1996). *Qualitative research: An interactive approach*. Thousand Oaks, CA: Sage.
- McApine, L., & Crago, M. (1995). The induction year experience in a cross-cultural setting. *Teaching and Teacher Education*, 11(4), 403-415.
- McCarthy, K. (2006). Good day, bad day. Teaching as a high-wire act. *Teachers College Record*, 108 (8), 1702-1705.

- McCulloch, G. & Richardson, W. (2000). *Historical research in educational settings. Doing qualitative research in educational settings* (Series editor Sikes, P.). Open University Press, Philadelphia, PA.
- McGinnis, J. R. & Parker, C. (2001). *What beliefs and intentions concerning science and mathematics and the teaching of those subjects do reform-prepared specialist elementary/middle level teachers bring to the workplace?* A paper presented at the annual meeting of the National Association for Research in Science Teaching, St. Louis, Missouri, March 26-29.
- McGinnis, J. R., Parker, C., & Graeber, A. (2000). *An examination of the enculturation of five reform-prepared new specialist teachers of mathematics and science.* A paper presented at the annual conference of the American Educational Research Association, New Orleans, Louisiana.
- McGinnis, J. R., Parker, C., & Graeber, A. (2004). A cultural perspective of the induction of five reform-minded beginning mathematics and science teachers. *Journal of Research in Science Education*, 41(7), 720-747.
- McIntyre, D. & Hagger, H. (1992) Professional development through the Oxford Internship Model, *British Journal of Educational Studies*, 40, 264-283.
- McLaughlin, M.W. (1990). The Rand Change Agent Study: Macro perspectives and micro realities. *Educational Researcher*, 11-16.
- McLaughlin, M.W., & Talbert, J.E. (1993). *Contexts that matter for teaching and learning*. Stanford, CA: Stanford University.
- McNeil, L. (2000). *Contradictions of school reform: Educational costs of standardized testing*. New York: Routledge.
- Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass.
- Metz, M.H. (1990). Hidden assumptions preventing real reform: Some missing elements in the educational reform movement. In S.B. Bacharach (Ed.), *Education reform: Making sense of it all* (pp. 141-154). Boston: Allyn and Bacon.
- Miller, G. (1997). Building bridges: The possibilities of analytical dialogue between ethnography conversation analysis and Foucault. In D. Silverman (Ed.), *Qualitative research*, 24-44. London: Sage.

- Mohr, D. J. (2000). *A qualitative analysis of the socialization factors experienced by induction phase physical education teachers from one university*. Published doctoral dissertation. West Virginia University.
- Moll, L. (1990). Introduction. In L. Moll (Ed.), *Vygotsky and education: Instructional implications and applications of sociohistorical psychology*. (pp. 1-27). New York: Cambridge University Press.
- Moon, T. R., Callahan, C. M., & Tomlinson, C., (2003). Effects of state testing programs on elementary schools with high concentrations of student poverty-Good news or bad news? *Current Issues in Education*, 6 (8). [Online]. Available: <http://cie.ed.asu.edu/volume6/number8/> [April 01, 2007]
- Moskowitz, J., & Stephens, M. (Eds.). (1997). *From students of teaching to teachers of students: Teacher induction around the Pacific Rim*. Washington, D.C.: U.S. Department of Education.
- Munby, H. (1984). A qualitative approach to the study of a teacher's beliefs. *Journal of Research in Science Teaching*, 21(1), 27-38.
- Napper-Owen, G., & Phillips, D. (1995). A qualitative analysis of the impact of induction assistance on first-year physical educators. *Journal of Teaching in Physical Education*, 14, 305-327.
- Nardi, B. A. (1996). Studying context: A comparison of activity theory, situated action models, and distributed cognition. In Nardi, B. A. (Ed.), *Context and consciousness: Activity theory and human-computer interaction*, 69-102. Cambridge, MA: The MIT Press.
- National Center for Education Statistics. (1999a). Indicator of the month: Teachers' feelings of preparedness. [Online]. Available: <http://nces.ed.gov/pubs2000/qrtlyspring/4elem/q4-6.html> [February 26, 2005]
- National Center for Education Statistics (1999b). *Teacher Quality*. Washington DC: Author [Online]. Available: <http://nces.ed.gov/pubs99/1999080.htm> [February 26, 2005]
- National Commission on Mathematics and Science Teaching for the 21st Century. (2000). *Before It's Too Late*. Report prepared for the U.S. Department of Education. Washington, DC: Author [Online]. Available: <http://www.ed.gov/americaaccounts/glenn/report.pdf> [February 26, 2005]
- National Commission on Teaching & America's Future. (1996). *What matters most: Teaching for America's future*. Woodbridge, CA: Author. [Online]. Available: www.nctaf.org/publications/whatmattersmost.html [February 26, 2005]

- National Research Council. (1996). National science education standards. Washington, DC, National Academies Press. [Online}.Available: <http://www.nap.edu/catalog/4962.html> [April 01, 2007]
- National Research Council. (2000). Inquiry and the National Science Education Standards. Washington, D.C.: National Academy Press. <http://books.nap.edu/books/0309064767/html/>
- National Research Council. (2002). *The Knowledge Economy and Postsecondary Education: Report of a Workshop*. Edited by P. A. Graham and N. G. Stacy. Washington, DC: National Academy Press.
- National Science Board (1999). Preparing our children: math and science education in the national interest. " NSB 99-31. Arlington, VA: National Science Foundation. [Online}.Available: <http://www.nsf.gov/nsb/documents/1999/nsb9931/nsb9931.htm> [February 26, 2005]
- Nelson, S.L. (1995) Mentoring new teachers: One middle school's experience, *Middle School Journal*, 26(5), 41-45.
- Nonaka, I., & Takeuchi, H. (1995). *The knowledge creating company: How Japanese companies create the dynamics of innovation*. London: Oxford University Press.
- NSTA (2000). Survey Indicates High Teacher Turnover, Job Dissatisfaction, *NSTA Reports*, 3, 5-6.
- Odell, S., & Ferraro, D. (1992). Teacher mentoring and teacher retention. *Journal of Teacher Education*, 43(3), 200-204.
- Ogawa, R. T., J. H. Sandholtz, M. Martinez-Flores, and S. P. Scribner. 2003. The Substantive and Symbolic Consequences of a District's Standards-Based Curriculum. *American Educational Research Journal*, 40(1), 147–176.
- Olitsky S. (2005). Promoting student engagement in science: Interaction rituals and the pursuit of a community of practice. *Journal of Research in Science Teaching*, 44 (1), 33-56.
- Olitsky, S (2006). Facilitating identity formation, group membership, and learning in science classrooms: What can be learned from out-of-field teaching in an urban school? *Science Education*, 91 (2), 201-221.
- Olitsky, S. & Loman, L. (2002). *Coherence, contradiction and formation of school science identities*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, New Orleans.

- Paese, P.C. (1990). A review of teacher induction: Are special programs needed for beginning physical education teachers. *Physical Educator*, 47(3), 159-165.
- Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62(3), 3007-322.
- Pajares, F. (1997). Current directions in self-efficacy research. In M. Maehr & P.R. Pintrich (Eds.), *Advances in motivation and achievement*. V10, (pp. 1-49). Greenwich CT: JAI Press.
- Palermo, T. D. (2002). *Practices of elementary principals in influencing new teachers to remain in education*. Published doctoral dissertation. Virginia Polytechnic Institute and State University.
- Paré, A. & Le Maistre, C. (2006). Active learning in the workplace: transforming individuals and institutions. *Journal of Education and Work*, 19(4), 363 – 381
- Patton, Q. M. (2002). *Qualitative research and evaluation methods*. Third Edition. Sage Publications, Thousand Oaks, California.
- Pontecorvo, C. and L. Sterponi. (2002) Learning to argue and learning to reason through discourse in educational settings. Ch. 10, CHAT book
- Price, J., & Valli, L. (2005). Preservice teachers becoming agents of change: Pedagogical implications for action research. *Journal of Teacher Education*, 56(1), 57-72.
- Proweller, A., & Mitchener, C. P. (2004). Building teacher identity with urban youth: voices of beginning middle school science teachers in an alternative certification program. *Journal of Research in Science Teaching*, 41(10), 1044 1062.
- Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*, 29, 4-15.
- Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In *Handbook of Research on Teacher Education*, second edition, J. Sikula, T. J. Buttery, & E. Guyton (Eds.), pp. 102- 119. New York: Macmillan.
- Richardson, V. & Placier, P. (2001). Teacher change. In Richardson, Virginia (Ed.), *Handbook of research on teaching* (pp. 905-947). Washington, DC: American Educational Research Association.
- Riggs, I., & Enochs, L. (1990). Toward the development of an elementary teachers' science teaching efficacy belief instrument. *Science Education*, 74, 625-637.
- Ritter, J. M., Boone, W. J., & Rubba, P. A. (2001). Development of an instrument to assess prospective elementary teacher self-efficacy beliefs about equitable science

- teaching and learning (SEBEST). *Journal of Science Teacher Education*, 12 (3), 175-198.
- Roberson, S. D., Keith, T. Z. & Page, E. B. (1983). Now who aspires to teach? *Educational Researcher*, 12, 13–21.
- Roberts J. K., Henson, R. K., Tharp, B. Z. & Moreno, N. P. (2001). An examination of change in teacher self-efficacy beliefs in science education based on the duration of inservice activities. *Journal of Science Teacher Education*, 12, 199-213.
- Roehrig, G.H., & Luft, J.A. (2006). Does one size fit all? The induction experiences of teachers from different preparation programs. *Journal of Research in Science Teaching*, 43, 963–985.
- Ross, J.A. (1994). *Beliefs that make a difference: The origins and impacts of teacher efficacy*. Paper presented at the annual meeting of the Canadian Association for Curriculum Studies.
- Roth, W. -M. (2002). *Designing learning communities*. [Online}. Available: <http://www.educ.uvic.ca/faculty/mroth/PREPRINTS/Design103.pdf> [May 10, 2004]
- Roth, W.-M., & LeeY.-J. (Accepted). Vygotsky’s neglected legacy: Cultural-historical activity theory. *Review of Educational Research*.
- Roth, W.-M., & Tobin, K. (2002). Redesigning an “urban” teacher education program: An activity theory perspective. *Mind, Culture, and Activity*, 9(2), 108-131.
- Rowell, P. M., & Gustafson, B. J. (1993). Beginning to teach. Science in the elementary classroom. *Alberta Science Education Journal*, 26, 4-10.
- Ryder, M. (1998). Spinning webs of significance. *Fourth Congress of the International Society for Cultural Research and Activity Theory* Aarhus, Denmark.
- Sadler, D. T. (2006). “I won’t last three weeks”: Preservice science teachers reflect on their student-teaching experiences. *Journal of Science Teacher Education*, 17(3), 217-241.
- Salish I (1997). *Secondary science and mathematics teachers preparation programs: Influences on new teachers and their students*. The Final Report of the Salish I Research Project. Prepared for the USDOE-OERI Grant no. R168V30004.
- Sclan, E. (1993). *The effect of perceived workplace conditions on beginning teachers. Work commitment, career choice commitment, and planned retention*. Dissertation Abstracts International, 54-08A.

- Schaller, J. S., & Tobin, K. (1998). Quality criteria for the genres of interpretive research. In J. A. Malone, B. A. Athew, & J. R. Northfield (Eds.). *Research and supervision in mathematics and science education*. Mahwah, NJ: Lawrence Erlbaum Associates. (pp. 39-60).
- Schmoker, M., & Marzano, R.J. (1999). Realizing the promise of standards-based education. *Educational Leadership*, 56(6), 17-21.
- Schon, D.A. (1983). *The reflective practitioner*. New York: Basic Books.
- Schneider, R. M, Krajcik, J. & Blumenfeld, P. (2004). Enacting reform-based science materials: The range of teacher enactments in reform classrooms. *Journal of Research in Science Teaching*, 42, 3, 283-312
- Scott, P. (2007). Questions about teachers' goals, learners' roles and the co-construction of knowledge. Scott, P., Mortimer, E., Lee, Y.-J., Engeström, R., Reveles, J. M., Kelly, G. J. & Durán, R. P. (2006). Forum: A sociocultural perspective on mediated activity in third grade science. *Cultural Studies of Science Education*, 1,(3), 497-515.
- Settlage, J. (2004). *Teacher intuition, student diversity & self efficacy: Issues in pre-service elementary education*. Paper presented at the annual meeting of Association for the Education of Teachers of Science, Nashville, January 8-11.
- Settlage, J., Kittleson, J., Hung, M. & Southerland, S. (2004). *Negotiating condensation: Children of varied English fluencies making sense of water cycle phenomena*. Paper presented at the annual meeting of the National Association of Research in Science Teaching, Vancouver, BC, April 1-4.
- Settlage, J. Southerland, S. A., & Smith L. K. (in review). *Teacher self-efficacy toward diverse students in elementary science teaching: Overcoming and value of self-doubt*. Submitted for review to Teachers and Teaching.
- Sfard, A. & Prusak A. (2005). Telling identities: In search for an analytic tool for investigating learning as a culturally shaped activity. *Educational Researcher*, 34(4), 14-22.
- Slavin, R. E. (2002). Evidence-based educational policies: Transforming educational practice and research. *Educational Researcher*, 31, 15-21.
- Shulman, L. S. (1987). Knowledge and teaching: Foundations for the new reform. *Harvard Educational Review*, 57, 1-22.
- Simmons, P.E.; Emory, A; Carter, T.; Coker, T; Finnegan, B.; Crockett, D.; Richardson, L.; Yager, R.; Craven, J.; Tillotson, J.; Brunkhorst, H.; Twiest, M.; Hossain, K.; Gallagher, J.; Duggan-Hass, D.; Parker, J.; Cajas, F.; Alshannag, Q.;

- McGlammetry, S.; Krockover, J.; Adams, P.; Spector, B.; LaPorta, T.; James, B.; Reardon, K.; & Labuda, K. (1999). Beginning teachers: Beliefs and classroom actions. *Journal of Research in Science Teaching*, 36(8), 930-953.
- Smith L. K. (2002). *An examination of the interactions between context and elementary teachers' science-related beliefs*. Unpublished doctoral dissertation, The University of Utah. Utah , USA.
- Smith, L.K. (2005). The impact of early life history on teachers' beliefs: In-school and out-of-school experiences as learners and knowers of science. *Teachers and Teaching: Theory and Practice*, 11, 5–36.
- Smith, L., & Southerland, S.A. (2007). Reforming practice or modifying reforms? Elementary teachers' response to the tools of reform. *Journal of Research in Science Teaching*, 43(3), 396-423.
- Smith, T. M., & Ingersoll, R. M. (2003). *Does teacher mentoring matter?* Unpublished manuscript.
- Smith, T. M., & Ingersoll, R. M. (2004). What are the effects of induction and mentoring on beginning teacher turnover? *American Educational Research Journal*, 41(3), 681–714.
- Smylie, M. (1990). *Teacher efficacy at work, in Teachers and their workplace*, Reyes, P. (ed), Newbury Park, Cal.: Sage Publications.
- Spector, B. (1989). About stages of professional development. *Science and Children*, 27(1), 62-65.
- Spillane, J. P., & Thompson, C. L. (1997). Reconstructing conception of local capacity: The local education agency's capacity for ambitious instructional reform. *Educational Evaluation and Policy Analysis*, 19(2), 185-203.
- Spradley, J.P. (1980). *Participant observation*. New York: Holt, Rinehart.
- Southerland, S.A., Gess-Newsome, J. & Johnstone, A. (2003). Defining science in the classroom: The manifestation of scientists' beliefs in classroom practice. *Journal of Research in Science Teaching*, 40(7), 669-691.
- Southerland, S.A., Johnston, A., & Sowell, S. (2006). Describing teachers' conceptual ecologies for the nature of science. *Science Education*, 90(5), 874-896.
- Southerland, S.A., Smith, L. K., Sowell, S., & Kittleson, J. (2007a). Resisting unlearning: Understanding science education's response to the United State's national accountability movement. *Review of Research in Education*, 31(4), 45-77.

- Southerland, S.A., Sowell, S., Granger, D.E., Kahveci, M., & Saka, Y. (2007b). *Working to measure the impact of professional development activities: Offering an instrument to quantify science teachers' pedagogical discontentment*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, New Orleans, LA.
- Southerland, S. A., Sowell, S., Kahveci, M, Granger, D.E., Gaede, O. (2006). *Working to measure the impact of professional development activities: Developing and instrument to quantify pedagogical discontentment*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Francisco.
- Sowell, S., Southerland, S., & Granger, E. (2006). *Exploring the construct of teacher pedagogical discontentment: A tool to understand teachers' openness to reform*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.
- Stake, R. E (1995). *The art of case study research*. Sage Publications, Thousand Oaks, CA, 1995.
- Stake, R. E. (2000). Case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2 ed., pp. 435-454). Thousand Oaks, CA: Sage Publications, Inc.
- Stockard, J. & Lehman, M. B. (2004). Influences on the satisfaction and retention of 1st-year teachers: The importance of effective school management. *Educational Administration Quarterly*, 40(5), 742-771.
- Strauss, A., & Corbin, J. (1998). *Basics of Qualitative Research: Techniques and procedures for developing grounded theory*. Thousand Oaks, CA: Sage Publications.
- Strong, M. (2004). Induction, mentoring and teacher retention: A summary of the research. A paper presented by Ed Pultorak at The Association of Teacher Educators of Europe October 25, 2004, Agrigento, Italy. [Online}. Available: http://www.ate1.org/pubs/uploads/ATE_retention2.pdf [February 26, 2005].
- Sunder, S. (2006). Economic theory: Structural abstraction or behavioral reduction. *History of Political Economy*, 38(1), 322-342.
- Supovitz, J. A. & Turner, H. M. (2000). The effects of professional development on science teaching practices and classroom culture. *Journal of Research in Science Teaching*, 37(9), 963-980.
- Sykes, G. (1999). Make subject matter count. *Journal of Staff Development*, (2), 50-51.

- Taylor, S.J. & Bogdan, R. (1998). *Introduction to qualitative research methods*. New York: John Wiley & Sons.
- Tellez, K. (1992). Mentors by choice, not design: Help-seeking by beginning teachers. *Journal of teacher Education*, 43 (3), 214-221.
- Texas Center for Educational Research. (1999). *Texas teacher recruitment and retention study*. Austin, TX: author.
- Tickle, L. (1994). *The induction of new teachers*. London: Cassell.
- Tikhomirov, O. K. (1988). *The psychology of thinking*. Moscow: Progress Publishers.
- Tobin, K, Tippins, D., & Gallard, A. J. (1994). Research on instructional strategies for teaching science. In D. L. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 45-93). New York: MacMillan Publishing Co.
- Tolman, C. W. (1999). Society versus context in individual development: Does theory make a difference. In Y. Engestrom, R. Miettinen, & R Punamaki (Eds.), *Perspectives on activity theory* (pp. 70-86). New York, NY: Cambridge University Press.
- Trumbull, D.J. (1999). *The New Science Teacher*. New York: Teachers College Press.
- Tsai, C. (2002). Nested epistemologies: Science teachers' beliefs of teaching, learning and science. *International Journal of Science Education* 24(8), 771-783.
- Tschannen-Moran, M., Woolfolk Hoy, A. & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research* 68, 202 - 248.
- Urzua, A. (1999). The socialization process of beginning teachers. An essay review of B.L. Brock & M.L. Grady's, *From first year to first-rate: Principles guiding beginning teachers*. *Journal of Teacher Education*, 50 (3), 231-233.
- van Manen, M. (1995). On the epistemology of reflective practice. *Teachers and Teaching: Theory and Practice*, 1(1), 33-50. . [Online}. Available: <http://www.ualberta.ca/%7Evanmanen/epistpractice.htm> [February 26, 2005]
- Varah, L. J., Theune, W. S., & Parker, L. (1986). Beginning teachers: Sink or swim? *Journal of Teacher Education*, 37(1), 30-34.
- Veenman, S. (1984). Perceived problems of beginning teachers. *Review of Educational Research*, 54(2), 143-178.

- Volkman, M. J., & Anderson, M. A. (1998). Creating professional identity: Dilemmas and metaphors of a first year chemistry teacher. *Science Education*, 82, 293-310.
- Vygotsky, L.S. (1978). *Mind and society: The development of higher mental processes*. Cambridge, MA: Harvard University Press.
- Watson, S.B. (2006). Novice science teachers. Expectations and experiences. *Journal of Science Teacher Education*, 17(3), 279-290.
- Weasmer, J., & Woods, A. M. (1998). I think I can: The role of personal teaching efficacy in bringing about change. *The Clearing House*, 71, 245-247.
- Weick, K. (1995). *Sensemaking in organizations*. Thousand Oaks, CA: Sage.
- Wells, G., & Claxton, G. (2002). *Learning for life in the 21st century: Sociocultural perspectives on the future of education*. Oxford, UK: Blackwell Publishing.
- Wenger, E. (1998). Communities of practice: Where learning happens. *Benchmark Magazine*, Fall Issue
- Wenger, E. (1998). *Communities of practice: Learning, meaning and identity*. Cambridge: Cambridge University Press.
- Wenger, E. (2000). Communities of practice and social learning systems. *Organization*, 7, 225 – 246.
- Wheatley, K. F. (2002). The potential benefits of teacher efficacy doubts for educational reform. *Teaching and Teacher Education*, 18, 5–22.
- Wiersma, W. (2000). *Research methods in education. An introduction* (7th edition). Needham Heights: Ally & Bacon. (pp. 198-217).
- Williams, B. (2001). *Adult learning theory: The mentoring connection*. (Report No. SP039775). Akron, OH: University of Akron. (ERIC Document Reproduction Service No. ED450101).
- Wolcott, H. F. (1992). Posturing in qualitative inquiry. In M. D. Lecompte, W. L. Millroy, and J. Preissle (eds.), *The handbook of qualitative research in Education*. Orlando, FL: Academic Press.
- Woolfolk, A. E., & Hoy, W. K., (1990). Prospective teachers' sense of efficacy and beliefs about control, *Journal of Educational Psychology*, 82, 81-91.
- Woolfolk, A. E., Rosoff, B., & Hoy, W. K. (1990). Teachers' sense of efficacy and their beliefs about managing students. *Teaching and Teacher Education*, 6, 137-148.

- Wong, P. A., Sterling, H. A., & Rowland, P. M. (September, 1999). *Effective induction practices for beginning teachers: A qualitative research evaluation study*. (Paper presented at the annual meeting of the Arizona Educational Research Organization, Flagstaff, Arizona).
- Worden, S. (2000). Design research in new media: Strength through collaboration and partnership." In:Pizzocar, S. (ed.) *Design Plus Research, Proceedings of the Politecnico di Milano Conference*. Milan: Politecnico Milano.
- Yager, R. E. (1992). Viewpoint: What we did not learn from the 60's about science curriculum reform. *Journal of Research in Science Teaching*, 29(8), 905-910.
- Yee, G. & Kirst, M. (1994). Lessons from the new science curriculum of the 1950s and 1960s. *Education and Urban Society*, 26 (2), 158-171.
- Yee, S. (1990). *Careers in the classroom: When teaching is more than a job*. New York: Teachers College Press.
- Yin, R. (2003). *Case study research: Design and methods 3rd edition*. Thousand Oaks, CA: Sage Publications.
- Youngs, P. (2002). *State and district policy related to mentoring and new teacher Induction in Connecticut*. New York, NY: National Commission on Teaching and America's Future.
- Yusko, B., & Feiman-Nemser, S. (2008). Embracing contraries: Combining assistance and assessment in new teacher induction. *Teachers College Record*, 110, p.-
<http://www.tcrecord.org> ID Number: 12789, Date accessed: February, 2007.
- Zavala, G. M. (N/A). Impact of teacher preparation paths on beginning teacher retention. [Online}. Available:
http://www.hiceducation.org/Edu_Proceedings/Glendelia%20M.%20Zavala.pdf
[February 26, 2005]
- Zeichner, K. M. (2003). The adequacies and inadequacies of three current strategies to recruit, prepare, and retain the best teachers for all students. *Teachers College Record*, 105(3), 490-519.
- Zeichner, K. & Gore, J. (1990). Teacher socialization. In W. Robert Houston (Ed.), *Handbook of research on teacher education* (pp. 329-348), New York: Macmillan.
- Zeichner, K. M., & Tabachnick, R. B. (1981). Are the effects of university teacher education 'washed out' by school experiences? *Journal of Teacher Education*, 32(3), 7-11.

Zembylas, M. (2004). Emotion metaphors and emotional labor in science teaching.
Science Education, 88(3), 301-324.

BIOGRAPHICAL SKETCH

Yavuz Saka was born in Ordu, Turkey in 1975. He earned his Bachelor's degree in Science Education from Gazi University in 1997. After his graduation, Yavuz worked as a science teacher in elementary, middle, and high school grade levels for public and private schools in Turkey between 1997 and 1999. He also taught several undergraduate courses in Gazi University where he started his graduate degree. In 2000, Yavuz was awarded a full scholarship by the Turkish Ministry of National Education to pursue his graduate studies in the United States.

In 2001, Yavuz started his Masters degree in Department of Science Education at University of Missouri at Colombia. Same year, Yavuz transferred to Florida State University and received his Masters degree in Science Education in 2003. During his graduate studies, Yavuz worked as a Lab Assistant in Department of Biochemistry and Chemistry. He also tutored physics, chemistry and mathematics for undergraduate students at The Center for Academic Retention and Enhancement at The Florida State University. Along with these work experiences, as a graduate assistant he worked with several professors and he taught a method course in Science Education in 2005 at Florida State University.

Yavuz Saka is currently working as a post doctoral associate participating in a National Science Foundation funded RET (Research Experience for Teachers) research project directed by Dr. Sherry A. Southerland at Florida State University. His responsibilities include designing a professional website for this research and participating in research activities including data collection, coding and analysis, and communication of research results.

Yavuz Saka's research interests are science education reform, teacher induction, and educational research methodology.