THE PROFESSIONAL BELIEFS AND PRACTICES OF SECONDARY SCIENCE
TEACHERS WITHIN THE CONTEXT OF A SITE-BASED SECONDARY SCIENCE
METHODS AND CURRICULUM COURSE

by

JAMES EDWARD SPELLMAN

(Under the Direction of J. Steve Oliver)

This interpretive research examines the professional beliefs and practices of six secondary science teachers involved with a site-based Secondary Science Methods and Curriculum course for pre-service teachers. Over the course of a semester, interviews, classroom observations, and teacher-generated models of teaching provided the sources of data. The analysis of these data show that the teachers strongly focus on issues about their students’ characteristics and needs when sharing their beliefs about being a science teacher. When analyzed using theoretical models of teaching found in the literature, these teachers make little indication that other aspects of teaching, such as pedagogical content knowledge or content knowledge, are at the cognitive forefront in their thinking about being a science teacher. Further analysis points to a number of constraints surrounding their jobs as science teachers that impact specific issues such as classroom management and the use of inquiry with their students. Implications from this research indicate that the beliefs and actions of these teachers provide a number of difficulties in achieving specific goals of science education reform. In addition, the data collection method of using teacher-generated models was useful in providing access to the beliefs about teaching held by the participants. Finally, a number of implications are discussed related to the design and development of site-based Methods and Curriculum courses for pre-service science teachers.

INDEX WORDS: Science Education, Beliefs, Teacher Education, Models, Case Study, Classroom Management, Inquiry
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DEDICATION

As a culmination of my long education, this dissertation is dedicated to my three family members instrumental in its completion. First, my parents, James and Joan Spellman, have provided many, many years of support, love, and encouragement in all aspects of my life. Along with their support, my wife’s selflessness and friendship through these past several years allowed me the freedom to pursue this degree. Thanks, Kristin.
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CHAPTER 1
INTRODUCTION

Overview of the Research

During fall semester of 2002, a cohort of pre-service teachers began their professional science education by enrolling in a collection of courses that are taught together and collectively known as Block I. This, of course, is not unusual. But this cohort, who had chosen to participate in their teacher education at a large research university in the southeastern U.S., was embarking on a program that, if not unusual, is outside the norm. In place of the traditional courses conducted largely within a university building, these pre-service teachers (enrolled in the Secondary Science Methods, Curriculum, and Practicum courses) attended a local high school where Block I is blended into the on-going secondary science teaching of that school. Pre-service teachers came to the school three days each week throughout the semester, spending approximately three hours there each day. A great deal of this time was devoted to working with a particular science teacher observing classes, assisting with instruction, and engaging in all the tasks that teachers do, e.g. grading papers, tutoring, making copies, etc. The group of university pre-service teachers also met as a group with the science education faculty and the science teachers at the school involved with the program for formal instruction that one would expect to be found in such courses held in more typical locations.

The cohort that began in the fall of 2002 was the third iteration of site-based methods courses taught by this institution. As with previous experiences, such a course
design was based on the idea of creating a cognitive apprenticeship (Collins, Brown, & Newman, 1989); introducing pre-service teachers into the complexities of teaching earlier and in greater depth than can be achieved from a traditional approach that is built around instruction based on the university campus. In general, traditional course designs only allowed pre-service teachers to be a part of authentic secondary classrooms for several weeks during the semester of their “methods” courses. A strong emphasis on reflective practice encourages and directs students to think critically about the events that they experience over the course of the semester. From a research perspective, the faculty members involved have sought to determine whether this approach helps to better facilitate reflection with these pre-service teachers (Oliver & Wallace, 2002).

One aspect that has yet to be included in the research with this field-based approach is the in-service teachers who host these students in their school and in their classrooms. Examining the beliefs, actions, and changes of these teachers should provide insight in terms of the expertise that veteran teachers have to offer, as well as the benefits they gain from becoming involved in this partnership. Throughout the years of conducting site-based methods, every effort has been made to make the teachers feel like partners.

This introduction provides an outline of research that involved such science teachers. A brief discussion of research literature that focuses on the role of beliefs in teaching and ways to challenge these beliefs provides an initial framework for looking at how the participants see themselves and their profession, as well as the impact of this site-based course on their professional beliefs. The research questions and methods that follow will inform a greater understanding about how secondary science teachers
approach their profession, providing future insight in course design for the partnering pre-service teachers as they begin their journeys from novice to expert educators.

Secondarily, the research examined the impact of the field-based methods course on the professional beliefs of the host teachers. By providing opportunities to engage more directly in teacher education and to confront their professional beliefs through frequent contact and discussion with university faculty, graduate students, and pre-service teachers, these practicing teachers have a unique opportunity to reflect on many aspects of how they view their job.

Relevant Literature

The volume of literature produced as an outcome of educational research expands each year as it has for the past several decades (Gage, 1963a; Wittrock, 1986; Richardson, 2001). Methods of inquiry into the issues of schooling continue to evolve and grow as well. However, there exists an ongoing debate about the appropriate preparation for teaching (Cochran-Smith & Fries, 2001). Even within the community of teacher education or within just science teacher educators there are many different practices, beliefs and knowledge that shape this preparation (Ellis, 2001).

The short history of educational research has focused on the goal of improving schools, although it has become evident that the term “improve” is really not as clear-cut as once was thought. The early times of educational research often used correlational studies to assess which processes brought about the best product (Gage, 1963b). Most often that product was defined as some type of achievement score. There has been a great deal written about the problems associated with using such scores for determining whether some type of intervention or approach to teaching “works”. Despite the pleas
from many within academia, a focus on achievement scores has endured and seems to be gaining a renewed strength (Sacks, 2001). However, other areas have increasingly been identified as in need of improvement in addition to achievement. For example, various lines of research have looked at issues such as how certain processes contribute to a student’s attitude toward science (Simpson & Oliver, 1990), students’ understanding of the nature of science (Lederman, 1986), developing problem solving skills (Jimenez-Aleixandre, Rodriguez, & Duschl, 2000), and becoming a better cooperative worker (Hand, Treagust, & Vance, 1997). Thus, the “product” part of the process-product line of research has widened considerably over the years from a previously narrow focus on achievement.

Regardless, it seems that the underlying goal of most research in education is to understand the processes of teaching and learning in order to better teach and prepare our future teachers. After all, it would be rather pointless to come to new understandings about learning or teaching and not share it with those working in the classroom. To have a pragmatic understanding about how to better prepare future teachers, one needs to have a great deal of understanding of how practicing teachers work in their everyday settings. It is important to understand the power of the process of enculturation of new teachers. Some type of metamorphosis likely occurs on the road from being a novice teacher to an expert teacher. Looking at the lives and practices of teachers gives us an idea as to what students in teacher education programs need to become in order to be successful (Goodson, 1992). As such, educational researchers have begun to recognize the significant impact that practicing teachers can make in developing a practical philosophy for teacher education (Cuban, 1990).
Beliefs and Teacher Education

Research over the past two decades has moved toward the pragmatic bridging of theory and practice as work began to inquire about the thinking processes of teachers (Clark & Peterson, 1986). In the course of trying to figure out why teachers do the things that they do, the research area of “teacher thinking” developed. A general goal in this group has been to better understand the thought processes of teachers by looking at: (1) teacher planning and action, (2) thoughts during instruction, and (3) beliefs (Carlgren, Handal, & Vaage, 1994). Models of how teacher thinking develops tend to include each of these three areas and their influence on one another. Research in these areas has been effective in changing our understandings about the relationships between the three. For example, once it was thought that thought processes affected action in a unidirectional relationship. More recently, support has grown indicating that actions are also capable of influencing one’s thought processes (Clark & Peterson, 1986).

A great deal of the early research into beliefs (also called implicit theories) was conducted in the area of examining teacher beliefs about student behavior and performance (Darley & Fazio, 1980). For example, one assumption that has guided this research was the concern about teachers who do not accept responsibility for the successes and failures of students in their classrooms, leading to a host of general research questions: Do teachers have equal expectations about the ability of their students? If not, why does the teacher believe that one student is “better” than another? Do these differences in beliefs and expectations translate into differences in student performance? What is the role of teacher education programs to get teachers to look at these beliefs in a constructive way?
In attempting to answer the questions above, past research in the area of teacher beliefs found that teachers vary in their levels of expectations for students, and their belief systems influence an array of ways to explain student actions and achievement (for a review of this, see Clark & Peterson, 1986). They generally believe, as opposed to the disclaimers given by investment brokers, that past performance is an indication of future results for how well a student does in a subject, leading to specific expectations for their students. When results are at odds with these expectations, it is not the belief system that gets challenged. Instead, differing attributes are assigned to different students (Peterson & Barger, 1984). When a “good” student does well, teachers tend to chalk it up to ability. If she does poorly, they may think of it simply as resulting from a lack of effort. If the poor student does well it must have just been a statistical aberrance, or luck. Similar beliefs are manifested in terms of a student’s race, as well (Wiley & Eskilson, 1978). In particular, teachers tend to believe that white students have more control over their failures and successes compared to students of color.

More recent research focusing on the beliefs of teachers has branched into a number of different areas of inquiry. Although studies continue to examine broad issues of education through a lens of teacher beliefs (e.g., Stipek, Givvin, Salmon, & MacGyvers, 2001), the examination of teachers’ thinking has illuminated a great deal of information across all aspects of education. From understanding science teachers’ conflicts about religion and evolution (Meadows, Doster, & Jackson, 2000) to studying changes in pre-service teachers’ epistemological beliefs (Brownlee, Purdie, & Boulton-Lewis, 2001), giving voice to teachers in research has helped bridge the gap between educational practice and theory (Shulman, 1987).
One specific area of inquiry that has used teacher beliefs in recent years has been in the study of issues surrounding diversity and multiculturalism. With the growing research in this area, published arguments have been developed that outline a research agenda for the study of teacher beliefs and multiculturalism (Bryan & Atwater, 2002). Prior research outlined how many teacher education programs are poorly designed to address the beliefs about diversity of pre-service teachers (Tatto, 1996). Studying the lives of teachers has identified a number of factors that may positively affect changes in beliefs about diversity (Smith, Moallem, & Sherrill, 1997). It was found that students who had experienced travel, discrimination, and cultures different from their own were more likely to have altered their previously held beliefs. Other researchers have looked to change pre-service teachers’ beliefs about diversity through multicultural courses at the university. Findings show that such courses can positively influence beliefs about diversity (Torok & Aguliar, 2000) although some students enrolled in multicultural education courses may downplay the impact of the role of society on low student achievement (Weisman & Garza, 2002).

Similar research about teacher beliefs can be found in the area of special education, and several of the research foci are similar to those described above in research about diversity and multiculturalism. For example, teacher beliefs have been used as a way to examine the impact of specific instructional strategies, such as reflective thinking and field experiences, on changing the beliefs of special education teachers (Renzaglia, Hutchins, & Lee, 1997). As special education practices have changed over the years, research has looked at how beliefs impact issues of inclusion and co-teaching. Both pre-service and in-service early childhood teachers have indicated beliefs about the
value of inclusion for students with special needs (Proctor & Neimeyer, 2001; Smith & Smith, 2000). Additionally, these studies have indicated to researchers how inclusion practices could be improved. Interviews with teachers working in co-teaching situations led researchers to argue that special education co-teachers were viewed as doing less in the classroom than regular-education co-teachers and that a co-teaching situation is not as valuable for students as many hoped (Austin, 2001). Such research in special education situations supports previous notions that educational reform initiatives need to take into consideration the beliefs of classroom teachers in order to be successful (Ballone & Czerniak, 2001).

Another area where teachers’ beliefs have informed educational research is in the use of technology in the classroom. Although research on beliefs and technology have covered many areas, a great deal of this seems centered on overcoming teachers’ lack of technology use in classrooms and determining the self efficacy of teachers about using technology. As an example of the former of these two lines of research, a case study of several elementary school teachers identified barriers to using technology to include a lack of equipment, a lack of time, and the belief that technology use was less important that other areas of learning (Ertmer, Addision, Lane, Ross, & Woods, 1999). From this work, the authors argue that changes should be made in professional development courses so that instructors would focus more on how individual teachers plan to use technology in their classes. Similar studies point to other beliefs voiced by teachers as barriers for integrating technology into the classroom, such as one’s own philosophical views about teaching (Albion & Ertmer, 2002). Other research on teacher beliefs and technology focus on efficacy and factors that contribute to teachers with high self-
efficacy about technology, such as increased computer use (Albion, 2001). Taking the self-efficacy beliefs into account, Ertmer (2001) argues that designers of instruction need to account for low self-efficacy with technology among teachers and work to improve their self-efficacy through the design of instruction.

As teachers have recently felt an increased need for proficiency in technology, reform efforts have also pushed teachers toward using a greater variety of assessments with their students. A framework using teachers’ beliefs has informed researchers examining issues related to the implementation of such assessments with various groups of teachers. Studies of pre-service teachers’ beliefs about assessment throughout teacher education courses highlighted the need in novice teachers for increased experience in using a variety of assessment methods (Lomax, 1996). Other studies have reported insight from experienced teachers’ beliefs about assessment. Broad studies about general assessment have illustrated factors influencing teachers’ beliefs about assessment, such as how teachers view the intended school curriculum (Delandshere & Jones, 1999). As new assessment strategies have emerged, researchers have documented the experiences and beliefs teachers have had with their implementation. Wolf and Gearhart (1997), for example, illustrated the dilemmas elementary teachers faced when new writing assessments were used. Beliefs about their students’ abilities as writers were found to contribute to their beliefs about the new assessments. The study of teacher beliefs has also been used to discern the influences of gender, experience, and other variables on the use of assessment (Nisbett & Warren, 2000). One finding from this study was that male teachers were less likely to use their classroom assessments as a feedback mechanism for developing future learning experiences.
Despite the different research areas of the many studies mentioned above, several common themes about using teacher beliefs in research are apparent. For example, many of the studies examined the beliefs of teachers as a way of assessing the degree to which specific education courses or experiences were successful in altering prior beliefs (e.g., Renzaglia, Hutchins, & Lee, 1997; Torok & Aguilar, 2000). As teacher educators examine the beliefs of teachers over the duration of specific experiences, such as student teaching, they are able to gain feedback about the usefulness of specific approaches in contributing to a shift in beliefs. Secondly, research on the beliefs of teachers has been used to understand how teachers think about and act toward changes that occur in their classrooms (e.g., Austin, 2001; Wolf and Gearhart, 1997). As varying levels of reform are played out in classrooms, research on teacher beliefs allows for an understanding about the difficulties, constraints, and barriers in the implementation of such changes. Lastly, research across the various educational contexts can help inform the design of professional development experiences for educators (e.g., Ertmer, 2001). The implications of such research often point to specific ways in which the research findings can be used in providing more pragmatic educational experiences for classroom teachers.

Belief and Action

Examining teacher beliefs has been a beginning point, but perhaps of greater importance has been the link between what a teacher believes and how a teacher acts. Teachers may not always act in accordance with their stated beliefs (Clark & Peterson, 1986; Keiser & Lambdin, 1996). Case study research has painted a picture of inconsistency between teacher belief and action of which teachers may not be aware (King, Shumow, & Lietz, 2001). In this study, teachers in an urban elementary school
professed a belief that valued “hands-on” and inquiry teaching with their students, although participant observation by the researchers failed to support that these teachers’ beliefs were implemented. Despite believing in the efficacy of such student-centered teaching, classroom lessons were often led by the teacher with a great deal of focus on lower-level academic skills.

In other cases, a teacher may be cognizant of the break between belief and action. For example, a teacher may believe that a general constructivist approach to education provides optimal opportunities for students, although he continues to exhibit a very didactic style of teaching (such as in the studied briefly described above). This dissonance between action and belief has led researchers to the idea that there are often constraints working against the manifestation of beliefs into action (Clark & Peterson, 1986; Keiser & Lambdin, 1996). These constraints may include a specific curriculum, administrative policies, time, student abilities, or available materials. The reason that this non-practicing constructivist teacher tends to lecture may reflect the norms of the school, the expectations of the principal, lack of available hands-on materials, or perceived ability of his students. And in keeping with the goals of this study, a side product of research on teachers’ beliefs and actions has arisen to identify how the complexities of constraints contribute to the difficulty of teaching in ways that are consistent with the philosophies of teacher education programs (Clark & Peterson, 1986).

Research on Beliefs in Science Education

Research in science education has somewhat lagged behind the pioneering work in teacher thinking and beliefs as evidenced by the lack of contributions from science education researchers found in the lengthy review of teacher thinking by Clark and
Peterson (1986). Further, in searching for literature related to teacher beliefs in science education, there does not seem to be a great number of studies focusing on the beliefs of practicing secondary science teachers. For example, most of the works reviewed by Clark and Peterson (1986) focused on teachers in elementary schools or in content areas such as language arts. Additionally, of the more than 500 research articles published in Science Education, Journal of Research in Science Teaching, and International Journal of Science Education from the years 2000-2002, fewer than ten were found which used a framework of beliefs focused on secondary science teachers, as research in this area has waned.

Though such a framework of beliefs has been used in research with secondary students (e.g., Zeidler, Walker, Ackett, & Simmons, 2002) and pre-service teachers (Haney & McArthur, 2002), the last decade of educational research witnessed the development of a number of publications and conference papers dealing with the beliefs and actions of science teachers. These were frequently situated within some type of context designed to increase the degree of reflection upon practice or to provide additional opportunities to confront existing belief systems (e.g., Bryan & Abell, 1999; Rop, 2002). It seems that a shift to constructivist and “hands on-minds on” teaching in science has been the backdrop in many cases (e.g., Beck, Czerniak, & Lumpe, 2000).

One example of research centered on such a shift was in the examination of beliefs by Tobin, Tippins, and Hook (1994). This research was a longitudinal case study about a teacher struggling with the desire to develop a more student-centered classroom. Though it is possible that this type of investigation would be appropriate to other disciplines within educational research, the context of teaching through open-ended
inquiry (as was the case in this study) seems more suited to science. Many science teachers learned science as a passive rhetoric of conclusions (Schwab, 1962). With the teacher in this particular case study, a lifetime of beliefs about how science should be taught was challenged, and the participant awoke to the desire to provide a classroom context that was more conducive to his intellectualized ideas of how science should be taught.

Other case studies report similar findings, but in the context of elementary education (Bryan & Abell, 1999). In their paper, research questions focused on the experiences and beliefs of the participant in thinking about science teaching and learning, the tensions that she felt in thinking about science teaching and learning, and the relationship between her experiences and beliefs. Data from studies such as those above have continued to document the difficulty in transitioning from a student of science into a teacher of science. Years of experience as a student often influence how one acts as a teacher, despite the fact that a teacher education program may have altered the belief system concerning effective teaching. Providing ways to reflect upon these tensions between beliefs and action should increase the likelihood of a future mesh between the two.

Among these more recent studies, beliefs were examined to better understand the meaning a chemistry teacher attributed to students’ questions about the subject (Rop, 2002). Other studies examined how the beliefs of secondary science teachers could be influenced by professional development experiences (Luft, 2001). In this case, the examination of beliefs was used as a means of assessment and impact of such a program. In addition to these studies, issues of curriculum design (Cheung & Ng, 2001), the use of
specific curricula (Lumpe, Haney, & Czerniak, 1998), science teacher efficacy (Wenner, 2001), and the implementation of various teaching strategies (Ballone & Czerniak, 2001) have each been examined through the use of teacher beliefs. Further, such research has yielded pragmatic understandings about specific issues of concern in science education, such as gender and ethnicity (Bianchini, Cavazos, & Helms, 2000). These researchers argue that exploring the beliefs of secondary science teachers about issues of gender and ethnicity can provide a deeper picture of the complexities of such issues; issues that should rely upon such research in developing methods of addressing problems and formulating solutions.

**Fostering Change in Belief Systems**

Of the various conclusions and implications that have been voiced in research on beliefs, the importance of reflecting upon one’s personal practice has become paramount since the contribution in this area by Schon (1983). Personal reflection and education may lead to changes in a belief system (Kagan, 1992). Although the belief system can be acquired as a youth, greater awareness of factors throughout life could cause changes in the system. This might happen quite slowly, as beliefs may act as a filter for incoming information. The idea of reflective practice has become pervasive in teacher education over the last decade. As a strategy to address the beliefs of pre-service teachers, it is becoming increasingly common to develop portfolios that document profession growth, journals, or work on other assignments with the purpose of promoting reflection about the act of teaching in order to complete a teacher education sequence.

Much of this stems from the dissatisfaction that traditional teacher education programs have had in dealing with changing the belief systems of their students, beliefs
that are developed throughout life that and to greatly influence ideas about how one should teach (Pajares, 1992). This is not to say that there happens to be a correct set of beliefs that a teacher should possess as he enters the school. But it is imperative to establish a routine of looking at one’s choices and actions in the classroom. Furthermore, it is not enough to simply look at what one does, but also why one chooses to do so. Beliefs may drive an individual’s actions, but experience and reflection may cause changes in beliefs (Schon, 1983). Although belief systems can change within an individual, there is a strong resiliency against doing so (Posner, Strike, Hewson, & Gertzong, 1982). Situations must exist in which current beliefs are challenged and examined. To provide such situations, science teacher educators are developing ways to increase pre-service field experiences and opportunities for reflection for pre-service teachers as they journey through the process of certification.

The Research

Rationale

Teacher education programs have begun a shift away from traditional approaches of presenting methods courses for their pre-service teachers (Tobin, Seiler, & Smith, 1999). Providing reflective opportunities has necessitated, in the minds of some, moving the classes out of the university and into public school settings. This is not a new idea, as calls for this type of arrangement can be found in the early 1970’s (Williamson & Barbour, 1971). At that time the design did not really seem to catch on, but recent work has gone into the successful implementation of field-based methods course. Queen’s University in Ontario, for example, changed their entire teacher education program to a field-based experience in the late 1990’s (Munby, 1999). Other programs have followed
suit with similar programs, such as at The University of Georgia in secondary science education (Oliver & Wallace, 2002). A great deal of the rationale for this program comes from a belief that a cognitive apprenticeship model of learning is appropriate for teacher education.

A framework of cognitive apprenticeship (Collins, Brown, & Newman, 1989), based on the theory of situated cognition, helps pre-service teachers move toward being experts by providing learning situations tied to authentic activities, contexts and cultures. However, the in-service teachers at these partner schools have yet to serve as participants in research in the site-based setting. Their presence and contribution to the success of a field-based program is quite necessary, but what benefit might these individuals receive from such an arrangement? Perhaps such a design provides experiences, opportunities, and a culture that is conducive to increased reflection on the part of these teachers.

Additionally, examining the teacher thinking of the host teachers is informative in designing and implementing a successful site-based methods course. First, these educators should help elucidate what goes into the complex activities of being a teacher. Being able to characterize and describe teaching from the voice and perspective of practicing teachers should give teacher educators a more clearly defined agenda as to what issues and topics they should address with their pre-service teachers. Secondly, if a site-based methods course provides an opportunity for professional reflection by in-service teachers, a stronger rationale can be argued for providing these types of opportunities. If so, they might be more strongly considered as a professional development experience for each of the teachers that are involved.
Context

In order to examine the issues mentioned above, a research study was designed in the context of a site-based Secondary Science Methods and Curriculum Course. This study was conducted during fall semester of 2002 as the pre-service teacher cohort of Block I worked with science teachers at a secondary school (fictitiously referred to as “Springfield”) near the university. This was the third iteration of site-based education for the professors teaching the courses, although the first one sited at Springfield. The participants for the study were six of the Springfield science teachers who were involved in partnering and mentoring university students enrolled in the course. No data were gathered from the pre-service teachers involved in the sequence of courses.

Springfield High School is located approximately 30 miles from two larger metropolitan areas, although the character of the community there is still largely rural. An average-sized high school in the state, the enrollment is approximately 1200 students. This is an increase of about 15% from the enrollment just five years previous. White students compose the largest racial/ethnic group with nearly 60% of the students. Almost all of the other students are African-American (around 37%), although there are a small percentage of students from Hispanic and Asian nations.

As measured by the number of students eligible for free or reduced lunches, Springfield has a substantial number of students who live near or below the poverty line. Close to half (around 43%) are eligible for these subsidies. Like many schools with high numbers of students from poor families, standardized test scores are below state averages. For example, only about 60% of the Grade 11 students, on average, passed the science portion of the state exit exam on their first attempt during the previous three years.
The school operates on an academic schedule that has come to be called the 4x4 block. Students attend four different classes each semester with each class lasting approximately 90 minutes. Science classrooms are scattered around the building, with no more than three of the seven teachers having rooms on the same hall. Because of this, most are not able to eat lunch with one another and interact as much as they might choose.

During the study, each of the full-time science teachers at Springfield hosted one or two university students in their classroom over the 15-week schedule. The pre-service teachers working in these classes were to engage in a great deal of observation, teaching, and other classroom activities (grading papers, helping with planning, etc.). The science teachers at the school worked collaboratively with the course professors to schedule and provide input about the course design. In addition to mentoring a pre-service teacher, most of the science teachers also were able to make a presentation to the entire group of pre-service teachers regarding a particular aspect of teaching, such as classroom management or science demonstrations. The in-classroom component for the pre-service teachers was much more involved and intensive than a traditional short-term practicum experience, although it was less so compared to student teaching.

Participants

Of the seven full time science teachers at Springfield, six were selected for inclusion in the research. One teacher was omitted from the study due to being on medical leave from the school at the beginning of the semester. Of the remaining six, four were female. The teaching experience of these six combined for over one hundred years in the science classroom. The most inexperienced of the six was in his fifth year at
the school. A more detailed description of each participant is included in Chapter 2 (pp. 36-116).

Researcher

Since this research focuses on the beliefs and actions of teachers in their classrooms, it is important to acknowledge and describe some of the beliefs about teaching held by the researcher. Prior to returning full-time to graduate studies, I taught for five years in a high-poverty, rural secondary school in eastern Georgia. The majority of my time was spent teaching Biology and Physical Science, often to “low-achieving” students. These experiences certainly shaped my understandings and beliefs about teaching science.

For the most part, I found science teaching to be a metaphorical juggling act. It was difficult to balance the planning, teaching, grading, and extracurricular duties of being in secondary school. This was especially true earlier in my career. Despite the short time in the classroom, I felt that by the end of my time there that I was a “good” teacher. Though my students were not necessarily more successful, I was more comfortable and dwelled much more on issues of instruction and less on management compared to my first couple of years.

I also felt compelled to juggle the way that I wanted to teach with the reality of high-stakes testing in the state. As these tests were implemented I did not think too much of them. As time passed and our students continued to do poorly, I felt compelled to teach in a way that I thought would better prepare them for the types of questions found on their exams. Though the instruction was at odds with my conceptions of good teaching, “teaching to the test” was much more effective in helping my students graduate
from high school. It was a decision that I wrestled with often, but justified it based on the joy expressed by my students when they received their passing scores. It also illustrated that I am actively aware that teachers do not always act in a manner consistent with their beliefs.

Prior to beginning this research, I engaged in the development of a model of teaching that is informative as to my beliefs about being a secondary science teacher (Figure 1.1). This model and my explanation of it provide strong insight as to how I view the holistic role of being a science teacher and the beliefs that I brought with me to this research. The following is a description of my model.

In viewing the model I have developed, it is clear that “Student Learning” is at the center. From both a long history of educational research and from thinking about how school works, the central measure of the effectiveness of a teacher is found in a student’s success. Although we may not agree about the relative worth in comparing the development of a student’s affect with a student’s cognitive growth, these are areas where we would expect an effective teacher to have influence. Regardless of how we define it, student achievement is ultimately the major factor in establishing the success of a teacher.

In addition to having students learn science content in my class, I also felt it was important for them to achieve other goals as well, such as working cooperatively, showing respect for one another, and becoming more responsible workers in and out of the classroom.

Boxes #2 and #3 in the model illustrate how teachers broadly affect student learning. It is difficult to describe this any simpler, but the activities in which a teacher engages during class, combined with what he or she does from the moment one class
Figure 1.1

Model of Science Teaching Developed by the Researcher
ends to the beginning of class the next day, encompasses all aspects of teaching. One might have a hard time arguing against this, since my model essentially includes any activity that a teacher engages in during a 24-hour period. Despite the simplicity presented here, thinking of teaching as an activity oscillating between active teaching and planning/preparation may help serve as a pragmatic way to think about teaching.

Beginning with the “in class” phase of being a teacher, we can begin to piece together my puzzle of what goes into teaching. The model illustrates activities that happen outside of class (discussed later) contribute much of what a teacher does in class. However, the “in class” phase of teaching should simply be understood as the 50 or 90 minutes (depending upon the school schedule) that occur between the tardy and dismissal bell. This is when the teacher has students in the classroom. Two teachers that have prepared identically for their classes will not engage their classes the same way, even if the two developed the same activities, handouts, and assignments. Several possible reasons for this are discussed below. Some factors, such as personality, are not included in the model of teaching because it seems unclear as to how science education and a teacher education program might be able to change an individual’s personality to make her more successful during class. However, in my own personal view of teaching I believe that a teacher’s personality is a substantial part of dictating what situations occur in a classroom. This personality aspect of teaching is “hidden” in the model as it likely filters parts of the model, such as how a teacher interacts with students or what types of activities are planned.

Many other factors, however, are of interest as we think of how to think about teaching. The model includes two areas that I feel are specific to the in-class phase of
being a teacher. The first of these is “student interaction” (#6). Within this construct I call student interaction, I largely imply dealing with how adolescent students interact with one another, both formally and informally. While teaching, I saw students exhibit a plethora of behaviors in class that spanned a continuum from very acceptable to very unacceptable. I view issues of classroom management as also falling into this category as teachers struggle with the process of drawing the line on that continuum that separates behaviors that the teacher can live with from behaviors that need to be addressed.

Another very important area that falls into the “student interactions” box is in developing understandings of how students work together. This may not always be different from classroom management, but what I think of here centers more on teacher actions such as grouping students together and developing ways to get as many students as possible involved with the class. Across classes or within the same class, students show a wide range of personalities; some are extroverted and vocal, while others are quiet and shy. Some students may have leaning disabilities, and others may have limited proficiencies in speaking or writing English. Managing such diversity can be complicated.

A second area affecting the “in-class” phase of my model is the need for teachers to assess their students (box 7). Although the development of assessment items generally occurs outside of class time, assessment itself occurs during class, which is why it is placed in this area of the model. Assessment is an on-going process in the classroom. Often we think of it only as chapter or unit tests, long-term projects, quizzes, or homework. Though these are important, I believe that the most important assessment teachers make are from their mental assessments of students through interacting with
them on a daily basis. These assessments are important because they may factor in to how the teacher happens to deal with particular students. For example, during my teaching I would occasionally think that certain students were lazy due to the observations I made in the classroom. Because of that, I might spend a considerable amount of time with such students trying to motivate them to achieve at the level I thought they were able. Consequently, if such “lazy” behaviors did not change, I might eventually conclude that nothing I would say or do was going to alter the behavior.

In the area of teaching that occurs outside of class, two factors seem to have major influences. Perhaps the major factor that mitigates what a teacher chooses to do in the classroom is the curriculum (box #9). In most cases, this is not an area where the teacher has a great deal of freedom in terms of what topics are chosen for a specific course. The teacher must have a great deal of knowledge about the content and sequence of the curriculum. The greater the familiarity, the greater the possibility exists of developing a course that has some type of theme or continuity to it. For instance, a teacher who understands how the facts and concepts of the biology curriculum in Georgia fit together should lead to a course that is seamless across all of the content standards in that subject. Having a strong content knowledge in this area is important, as well. Over my five years of teaching experience, the content of the subjects I taught became more familiar. Despite an undergraduate degree in biology, my understanding of life science concepts during my first year of teaching paled in comparison to what it was in my last. I better understood how the various topics fit together and could tie sections of the course together much more effectively.
Peer interaction (#8), or lack of it, may affect the choices that a teacher makes in preparing for classes. On one end of a continuum, some teachers are active in talking to their peers about problems and successes, increasing the opportunities to give and receive wisdom about best practices. On the other end is the teacher who has decided upon how and what to teach, needing zero input from anyone else. The individual members of a science department may be found across all aspects of such a continuum, developing a degree of collaboration within the group. In my experience, interacting with my teaching peers at the school level was more important in terms of providing social bonds and friendship. It made the school a place where I wanted to work. I believe that the need for collaboration about course content is more prevalent with less-experienced teachers and with teachers new to a specific subject.

In the model, boxes #10 and #11 are areas that affect teaching both inside and outside of the class. External constraints tend to be an area where individuals have little grasp as they go into their first job. These constraints exist for what the teacher is able to do in the classroom. For example, certain laws and policies prohibit certain actions, language, and behavior. As a result, teachers increasingly have to pay a greater deal of attention to what they do and say around their students. Liability, in the age of lawsuits, tends to guide a great deal of what happens. This is true outside of classroom time, as well. At my school, we struggled with high-stakes testing and were encouraged into practices that would help students better prepare for those exams. Funding may not be available for field trips or materials. As such, I was not always able to teach a specific laboratory activity due to the need to purchase alternative materials that were less costly. Lastly, situations may push a teacher to work in a course in which his or her comfort
level and self-efficacy is not very high. For example, a teacher who prefers Biology may end up teaching Physical Science. Having a lack of subject matter expertise in Physical Science constrained my choices of instruction over the first couple of years that I taught it due to spending more time better learning the content.

Understanding the sociology and psychology of students is important to becoming a good teacher. Although this relates somewhat to “student interaction” (#6), having an understanding of both of these areas is crucial to helping student learn. Again, having general ideas of group dynamics can influence choices that are made during class activities as well as pointing out which activities might be better than others during the planning phase. After a short time in teaching I began to believe that most of the students who were “troublemakers” in class were usually following the lead of one or two particular students. If the ringleader of misbehavior happened to be absent from class, misbehaviors usually apparent in other students seemed to vanish. This lead to understanding how to deal with different students in different ways. It also influenced how students were grouped for particular activities.

Understanding how students make sense of the content that is presented to them is also very important. This influences out of class teaching by pointing to the selection of certain methods of teaching. It can also influence in-class teaching by prompting certain responses in dealing with student behavior or in providing learning examples during class discussions. After several years of teaching the same subject, for example, there were areas where I learned to anticipate greater than normal difficulty for students in understanding the content. One area where my “at-risk” students struggled in Physical Science was the inverse relationship between frequency and wavelength. This led to
using more tactile and kinesthetic teaching strategies to help the students better visualize the concepts.

The final two boxes of the model are arguably among the most important, especially when viewed in light of recent research in science education. Planning (#4) and reflection (#5) mediate the transition between in-class and out-of-class teaching. They lie at the heart of teaching so much that we could likely remove all boxes in the model, leaving only numbers 1-5, and still have a very accurate idea of what constitutes being a teacher.

Teachers plan for the next day, the next week, the next unit, or even for the next year. A great number of things go into this planning, including all of the items that I previously discussed as being a part of before/after class teaching. In essence, almost all that is done by a teacher between classes can be considered some type of planning. Combining the factors of curriculum requirements, past experience, knowledge of students, etc., the teacher puts into place some type of Plan to best go about reaching the center of our model with enhanced student learning. Perhaps the hallmark of exceptional teachers is being able to juggle all of these constructs (knowledge of curriculum, past experience, etc.) that surround teaching, successfully planning for what happens in class and executing those plans.

After the class ends (and even during class) the teacher often thinks about whether or not the choices made have been appropriate. Again, the factors influencing in-class teaching will influence this reflection. Did the students understand the material? Were my choices in grouping appropriate? Was the test too hard? Do I have time to review this information again tomorrow? In reflecting on these questions, I was always led back
to the processes of planning. Developing the cycle of planning influenced by reflection on one’s practice is crucial to helping students learn.

This model of teaching that I developed is largely based on personal experiences in one particular public school. I imagine if I had worked at a different school that I would have a slightly different model. Nevertheless, I feel that the “big picture” lesson to take away from such a model is the degree of complexity in being a good teacher. It is much more than simply looking at what objectives are to be taught, putting a few materials together, and telling the students what to do. I also believe these complexities compound at schools populated with students struggling in their attempts in academic achievement. For example, I recall a colleague who interviewed at a high school that served one of the more affluent school districts in the state. He was shocked that the high-stakes exit exam in the state was never mentioned during the course of his discussions with school officials. Because of the high failure rate of students at our school (not the case where he interviewed), focusing on the state tests was a substantial part of our teaching thought processes. However, I have come to believe from discussions with colleagues at other more affluent schools that interacting with parents might be a category they would include not found on my model.

The last thing I would like to mention about the model is that I believe it takes experience and time in classrooms to develop a deep understanding about the various parts. My understanding of the science curriculum, how best to interact with students, and the processes of schooling were learned at school, not in the university classroom. I believe the university classroom is essential to provide a scaffolding for pre-service teachers, but spending time with practicing teachers and typical students is necessary to
make sense out of the time spent with science teacher educators in the university. I
would think that my model holds little meaning to anyone who lacks experience inside a
secondary school classroom.

Research Focus and Questions

The faculty involved in previous iterations of this university’s site-based Methods
and Curriculum courses used interview, observational, and anecdotal data from their pre-
service teachers to assess the effectiveness of the course in meeting its goals. Though the
structure of this course could be considered non-traditional, the goals remain identical to
the same course taught in the traditional approach. The secondary science teacher
education program has five strands and six themes for their students. The strands are: (1)
science teacher with an understanding of the discipline of science and its nature; (2)
science teacher as communicator; (3) science teacher as multicultural educator; (4)
science teacher as ethical decision maker; and (5) science teacher as a reflective
practitioner in school-based experiences. The six themes are: (1) learning; (2)
curriculum; (3) planning; (4) conducting instruction; (5) evaluation; and (6) ethics (moral
philosophy), values, and beliefs. It is believed that providing pre-service teachers with a
site-based experience early in their professional education sequence should be effective
in addressing these strands and themes.

The broad goal of this research is to provide information that will make such a
site-based experience more valuable for those enrolled by understanding the professional
beliefs and practices of the secondary science teachers with whom the pre-service
teachers work. Within the context of this site-based methods course, this study was
specifically conducted to answer the following research question:
• What are secondary science teachers’ beliefs about science teaching and learning?

Additional research questions that guided the study included:

- How do these teachers describe and define through models their beliefs regarding science teaching and learning?
- How are their beliefs expressed in their professional practice?
- How does the teachers' participation as mentors in a field-based methods and curriculum course influence their thinking about science teaching and learning?

Methods

In order to answer the research questions, a case study approach was used. Typical of case studies, the main source of data for answering the research questions came from the use of observations and interviews (Merriam, 1992). Participants engaged in interview sessions near both the beginning and end of the semester. Prior to the initial interview, participants were asked to develop a “model of teaching” (Appendix A). The purpose of this exercise was to allow each teacher to share his/her holistic views about being a science teacher with as little researcher bias as possible influencing their words. The development of this model is similar to creating a concept map, which has been used in numerous studies as an assessment tool or a way to get at the conceptions that individuals have about specific topics (Nicoll, Francisco, & Nakhleh, 2001; Powell, 1992). In this case, the concept is “teaching”. Although the participants would eventually be interviewed about a number of issues related to teaching, the goal of using such a method was to have the participants share what they thought were the important
aspects of teaching prior to answering questions about what the researcher thought was important.

The initial interviews lasted in duration from 60-120 minutes, depending upon the participant (in a couple of cases, these occurred over more than one sitting due to time constraints), and had several goals. The first goal of the interview was to allow the participant to explain their model of teaching. In doing so, the participant was able to make sense of what he or she developed to the researcher without the researcher having to make assumptions or guesses about the meanings within the model. Secondly, the interview was used to acquire an autobiographical teaching history of the science teacher. This allowed the researcher to have a better sense of the person behind the teacher. Lastly, the interview explored how participants viewed a great number of educational-related terms in their importance or use in teaching science (see Appendix B for the interview protocol).

In developing this initial interview protocol, the content largely came from the course syllabus of the pre-service teachers. The rationale for this was to examine the practicing teachers’ beliefs about the concepts being taught in the Methods and Curriculum courses. For example, among the topics covered by the professors were “classroom management” and “planning”. Thus, examining their beliefs about these topics should prove useful in connecting the educational goals of the professors with the beliefs and practices of the partnering teachers.

The goal in the use of participant observation was to make connections between the teachers’ words in interviews with their actions in the classroom. Since a great portion of the pre-service teachers’ time in the classroom was spent in observing the
science teacher, combining the observations with the interviews pointed out which aspects of teaching were more explicit to an observer and which were more implicit. Each participant teacher was observed eight to ten times over the semester for at least 60 minutes in each visit. This resulted in approximately 500 to 600 minutes of observation of each teacher. Each participant was observed during the same class throughout the research in order to ensure some degree of continuity across observations. Field notes were taken using a laptop computer during these observations. Field note data detailed class activities, teacher behaviors, student behaviors, interactions of individuals, and other pertinent events witnessed during the class. Examples of notes taken from classroom observations are presented in Appendix C.

The interviews conducted at the end of the semester served two purposes (see Appendix D for protocol). First, participants were asked to talk about their experiences in the site-based course. Secondly, each participant was asked questions specifically pertaining to events that were observed in their classrooms. These may have been related to interactions with specific students or to question strategies and methods seen throughout the visits.

The researcher audiotaped and transcribed all interviews for use in analysis. In proceeding with the analysis of interview data, the coding of these interviews was influenced by concepts and ideas developed prior to engaging in the interview process or looking at the data. Miles and Huberman (1994) support this idea of starting with a set of theoretical or conceptual-based codes prior to beginning the research, and these guided the choice of interview questions. As stated before, since issues such as “classroom management” were of importance, segments of transcript were analyzed for examples of
teachers’ beliefs about such a particular concept, although other concepts arose (as generated by the participant) from the interviews. In coding the data, the approach mentioned by Strauss and Corbin (1990) was adopted: “...the analyst also might code by analyzing a whole sentence or paragraph (original emphasis). While coding a sentence or paragraph, he or she might ask, ‘What is the major idea brought out in this sentence or paragraph?’ Then, after giving it a name, the analyst can do a more detailed analysis of that concept” (p.120). Thus, beginning with this idea, the first of three steps was begun in coding. During open coding (Strauss & Corbin, 1990) all transcripts were read with sentences and paragraphs given various labels based on ideas, beliefs, or aspects of teaching represented. Some similar codes were combined together. Various code names came either from the preconceived interview topics or from the words of the participants. Axial coding (Strauss & Corbin, 1990), examining connections among codes, followed. In practice, open and axial coding was somewhat simultaneous. From this, a chart was developed for each participant that illustrated transcript excerpts supporting each code. An example of the coding scheme using open and axial coding is included in Appendix E.

Examination of these charts revealed certain concepts to have a higher prevalence than others. Since the interpretive nature of the research was begun with a very broad research question, specific topics were chosen as a focus for reporting the research. Several of these concepts (classroom management, interacting with students, non-teaching duties, etc.) are discussed in the following chapters. After deciding upon the focus of each of the following three chapters, selective coding (Strauss & Corbin, 1990) discriminated among codes that were relevant to the research question. From these codes
emerged the themes presented in each article. An example of the coding process is included in Appendix D.

Overview and Rationale of Remaining Chapters

Due to the broad nature of this investigation and the vast amount of data gathered over the course of the semester, the presentation of the data is given in the format of separate journal-type articles. In determining the focus of the three articles, considerations were taken to include chapters that would address the broad initial research questions. All three chapters address the overarching question (i.e., secondary science teachers’ beliefs about science teaching and learning); while the additional questions are examined to varying degrees across the chapters. Choices of focus were made among those concepts that were more prevalent in the data. The final decisions of what to include in the chapters weighed which topics would be informative about broad issues of science education, as well as pre-service science teacher education.

Chapter Two uses the teacher-generated models to provide a broad profile of the ways the secondary science teachers illustrate their holistic beliefs about being a teacher. The data from the models, along with the initial interviews, point to specific areas of emphasis among the knowledge bases of teachers. The interviews from the end of the semester are used to examine whether their involvement with this site-based course impacted the way they think about being a science teacher.

The next two chapters focus more on specific issues of science teaching that emerged from the data and answer both the overarching research question of the dissertation as well as the relationship between the beliefs and practices of the teachers. In Chapter Three, interview and observational data are used to illustrate the constraints
faced by teachers to teach science through inquiry. The beliefs held by teachers about the science curriculum, their students, time, and additional teaching responsibilities suggest a number of reasons why increases in the use of inquiry have not been widespread among secondary science teachers.

Finally, Chapter Four uses interview and observational data from three of the Grade 9 Physical Science teachers to examine issues of classroom management. The degree of order varied considerably across these three classes as one teacher generally maintained an orderly, focused science class while another teacher often monitored a great deal of chaos. Factors such as a teacher’s personality, the students in the class, the teacher’s perceived role, and the physical classroom space all are identified as having influence over issues of classroom management in a secondary science class.

Many of the issues addressed in these chapters are tied together in Chapter Five. Additionally, broader issues are addressed, as well. This research informs basic issues of research in the area of teachers’ beliefs. The link between belief and action, as well as how teachers speak of changes in belief were prominent. Secondly, the role of a site-based course as a strategy to address teachers’ beliefs is examined. From a practical perspective, this research lends support for a site-based course in meeting the goals of the secondary science education program and informs future design that could benefit both pre-service and in-service teachers involved with a program. In conclusion, the methodological issues of this research are addressed.
CHAPTER 2

TEACHER-GENERATED MODELS OF TEACHING IN EXPLORING THE BELIEFS OF EXPERIENCED SECONDARY SCIENCE TEACHERS

Overview

In order to fully understand teaching, it is necessary to study the entire person of the teacher (Goodson, 1981). The examination of the professional beliefs of teachers has helped move educational research more closely to the everyday practices of the classroom (Clark & Peterson, 1986). Additionally, other researchers have developed theoretical models about the knowledge bases of teachers (Barnett & Hodson, 2001; Shulman, 1987). These knowledge bases (or portions of them) are often used as a rationale in developing areas of focus for pre-service and in-service teacher education and research (e.g., Lowery, 2002; van Driel, Verloop, & de Vos, 1998).

This research being reported examines the professional beliefs of six science teachers to explore their views about teaching and their role as teachers. Each participant constructed their own model, or drawing, to show how they conceptualized being a science teacher. The content of these models and subsequent interviews were examined in light of the knowledge bases of teachers outlined by Shulman (1987) and Barnett and Hodson (2001). Using these knowledge bases as a reference, certain areas of teaching were found to be emphasized more than others. For example, the science teachers place greater stress on having knowledge of their students than in science content knowledge.
During the course of this research, each participant was involved in mentoring a pre-service science teacher in a site-based Secondary Science Methods and Curriculum course. Combining the information gathered from the teacher-generated models with interviews at different points of the academic term provides information that sheds light on the use of such models as data sources in research about teacher beliefs. This article concludes with future lines of research stemming from this study and the implications of using models to study teacher beliefs.

Relevant Literature

During the 1980’s, educational research began a shift to bridge the existing chasm between theory and practice (Shulman, 1986). Much of this research in the area of teacher thinking (Clark & Peterson, 1986) recognized the importance of involving teachers more fully in the research agenda, examining areas such as planning, thoughts, and beliefs (Carlsten, Handal, & Vaage, 1994). Though teachers’ voices have become a stronger part of academic research, teacher educators still point to the problematic relationship that exists between theory and practice (Roth & Tobin, 2001). The failure to recognize the realities of classrooms and their cultural contexts is likely to impede pre-service teacher education and curriculum reform (Barnett & Hodson, 2001; Roth & Tobin, 2001). Developing a better understanding about the knowledge that experienced teachers have about the classroom is important in providing a quality education for students, useful curriculum development, and good teacher education (Barnett & Hodson, 2001).
Studying the Beliefs and Lives of Teachers

Goodson (1981) stresses the importance of knowing about the identity of teachers to better help in understanding educational concerns: “In understanding something so intensely personal as teaching, it is critical that we know about the person the teacher is. Our paucity of knowledge in this area is a manifest indictment of the range of our sociological imagination” (p. 69, emphasis original). Specifically, Goodson (1992) argues that three areas of rationale exist for studying teachers’ lives. First, it can provide a range of insights into moves to restructure and reform schooling. Additionally, it can provide information about the importance of experiences prior to pre-service education in shaping the identity of a teacher. Lastly, studying teachers’ lives will help in better understanding issues of gender in teaching. From understanding the personal side of teaching, the link between ‘school life’ and ‘whole life’ is better elucidated (Goodson, 1992), helping to provide insight to the thoughts behind teachers’ practices (Wenger, 1998).

A number of studies from science education research, particularly during the decade of the 1990’s, used case studies and in-depth data collection in classroom settings with practicing teachers. From these studies, a number of issues related to the above claims of Goodon (1992) and Wenger’s (1998) have been reported. Examples can be found showing how teachers’ beliefs relate such diverse areas as teaching from a constructivist perspective (Tobin & LaMaster, 1995) to implementing technology in urban school settings (Songer, Lee, & Kam, 2002).

In one of the earliest studies examining the actions of science teachers through their professional beliefs, Cronin- Jones (1991) followed two different middle grades
teachers as they journeyed through the process of beginning a wildlife species curriculum with their students. The findings from this study showed that these two teachers were influenced by a number of beliefs in terms of implementing this new curriculum. These teachers’ beliefs about how students learn, the teacher’s role in the classroom, the ability levels of their students, and the importance of content topics influenced the way classroom activities and lessons were structured. These beliefs, especially those that are negative, may prohibit such a curriculum from being implemented as designed.

Other studies have looked at the beliefs and practices of science teachers in illustrating constraints felt by teachers as they work in the classroom (Brickhouse & Bodner, 1992). The case study of McGee in this research points to how certain beliefs may conflict with one another as science teachers work to design and facilitate science learning. McGee’s belief about how school science should be structured was at odds with his beliefs about using inquiry with his science students. Additionally, this study points out the need for strong mentoring of new teachers as they enter the classroom early in their careers.

More recent research has looked at other classroom barriers, such as increasing the use of technology in schools (Songer, et al., 2002). In the context of an urban middle school, several teachers worked to use a technology-rich weather program in their science classes. These teachers indicated a number of barriers and constraints they believed made the use of such a program problematic. Among these were inadequate space, inadequate time for preparation, low technology understanding, large class sizes, and lack of administrative support. Though a number of positive effects were noted from the use
of such an inquiry approach, these numerous constraints voiced by the teachers seemed to prohibit the realization of the full potential of such instructional approaches.

Researchers have also looked at how a teacher’s holistic understanding of her beliefs about being a teacher impact science teaching (Tobin & LaMaster, 1995). Approaching the beliefs of the teachers through her use of metaphors, it was found that certain beliefs about being a science teacher were more useful than others in attaining the type of student learning that was desired. For example, the belief of the teacher acting as a social director seemed to positively facilitate constructivist practices in the classroom. In this case, the social context of the teaching/learning was an important mediator in the usefulness of particular beliefs.

From these studies (and others) about the beliefs of teachers, researchers have been able to paint an in-depth portrait of the complexities of being an educator. Through such case studies, science teacher educators become privy to the difficulties many teachers face in their classrooms. Teachers must deal with a number of other issues in addition to simply translating a curriculum for their students. Such research points to how beliefs about educational contexts, beliefs about the curriculum, beliefs about students, and content knowledge influence the actions found in science classrooms. Additionally, these studies begin to offer an understanding about the broad beliefs and knowledge science teachers have as it relates to working as a teacher.

Knowledge Bases of Teachers

Few writings have enjoyed an influence on educational thought and research such as Shulman’s (1987) delineation about the knowledge bases of teachers. Since the time of its publication over 15 years ago, hundreds of research and theoretical pieces have
been written that cite this work as a reference (I.S.I. Web of Knowledge, n.d.). Wanting to create a more professional notion of teaching, Shulman and his colleagues spent a great deal of time among teachers, observing and studying their research participants as they learned to teach. One of the conclusions from this work was the realization that many aspects of teaching were missing from attempts to create research-based definitions of good teaching. He wrote:

Critical features of teaching, such as the subject matter being taught, the classroom context, the physical and psychological characteristics of students, or the accomplishment of purposes not readily assessed on standardized tests, are typically ignored in the quest for general principals of effective teaching. (p. 6)

Shulman (1987) provides seven knowledge bases for teachers (although he implies there could be more). These areas (listed in Table 2.1) are: (1) content knowledge; (2) general pedagogical knowledge (referencing the broad principles and strategies for classroom management and organization that appear to transcend subject matter); (3) curriculum knowledge (grasp of the materials and programs that serve as tools of the trade for teachers); (4) pedagogical content knowledge (the mixture of specific content and pedagogy); (5) knowledge of learners and their characteristics; (6) knowledge of educational contexts (such as understanding how the classroom operates, the running of school systems, and characteristics of the community); and (7) knowledge of educational ends, purposes, and values.
Table 2.1

Shulman’s (1987) Categories of Teacher Knowledge Bases

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Content Knowledge</strong></td>
</tr>
<tr>
<td>2</td>
<td><strong>General Pedagogical Knowledge</strong> – with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter.</td>
</tr>
<tr>
<td>3</td>
<td><strong>Curriculum Knowledge</strong> – with particular grasp of the materials and programs that serve as “tools of the trade” for teachers.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Pedagogical Content Knowledge</strong> – that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding.</td>
</tr>
<tr>
<td>5</td>
<td><strong>Knowledge of learners and their characteristics</strong></td>
</tr>
<tr>
<td>6</td>
<td><strong>Knowledge of educational contexts</strong> – ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures.</td>
</tr>
<tr>
<td>7</td>
<td><strong>Knowledge of educational ends, purposes, and values</strong> – includes their philosophical and historical grounds.</td>
</tr>
</tbody>
</table>
Teachers acquire these knowledge bases from four major sources (Shulman, 1987). First, formal educational settings prepare teachers to better understand the content they teach and the workings of the particular discipline. Secondly, teachers draw upon the materials and structures of education, such as curricula and teachers’ organizations. A third influence on teacher knowledge comes from educational research and philosophical literature. Lastly, the wisdom of practice teaches educators a great deal about how to teach, although much of this area is never made explicit.

More recent ideas about teacher knowledge incorporate aspects of Shulman’s knowledge bases with additional models and classroom research (Barnett & Hodson, 2001). Their notion of pedagogical context knowledge draws from four types of knowledge found in teachers’ talk about their practice: (1) academic and research knowledge; (2) pedagogical content knowledge; (3) professional knowledge; and (4) classroom knowledge. These four areas are similar to Shulman’s in that certain categories of his have been combined into more inclusive domains. For example, Barnett and Hodson’s (2001) category of professional knowledge encompasses portions of Shulman’s knowledge of educational contexts and knowledge of educational ends, purposes, and values. Despite the fewer number of categories, however, Barnett and Hodson’s (2001) categories seem much broader (these are listed in Table 2.2). The development of these research-based models is useful as teacher education works toward preparing prospective teachers for the complexities of the profession. For instance, Barnett and Hodson (2001) provide a rationale for the use of pedagogical context knowledge:
### Table 2.2

Categories and Major Components of Science Teacher’s Knowledge on the Knowledge Landscape (Barnett and Hodson, 2001).

<table>
<thead>
<tr>
<th>Category</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Academic and Research Knowledge</td>
<td>Knowledge of Educational Research, Scientific Knowledge, Reflection-on-Action, Other Teachers’ Experience (through) Networking, Personal Philosophy of Science Education</td>
</tr>
<tr>
<td>2. Pedagogical Content Knowledge</td>
<td>Use of Strategies for Science Teaching, Use of Strategies for Assessing Science Learning, Use of Scientific Resources, Use of Other School Resources, Use of Community Resources, Use of Strategies for Integrating Science with Other Subjects, Use of Strategies for Personalizing Science Education</td>
</tr>
<tr>
<td>3. Professional Knowledge</td>
<td>Political and Sociological Knowledge of Schooling (&quot;the pipeline&quot;), Professional Knowledge of Education, Teacher Lore</td>
</tr>
<tr>
<td>4. Classroom Knowledge</td>
<td>“Psychological” Knowledge of Students, “Sociological” Knowledge of Students, Facilitation of Learning, Knowledge of Individual Students, Behavioral Feedback from Students</td>
</tr>
</tbody>
</table>
Perhaps the most important aspect of our idea, however, lies in the elaboration of teaching as a complex and subtle activity which requires many forms of knowledge – situated, on the one hand, within one classroom on one day with one class of students, yet, at the same time, situated within the broadest expanses of the teacher’s knowledge landscape. (p. 447).

The usefulness of such theoretical notions of teaching lies in their ability to align closely with the realities found in typical classrooms with typical teachers and students in order to prepare student and novice teachers understand the knowledge needed in the classroom (Barnett & Hodson, 2001). An examination of the lives and thoughts of such teachers should help refine these models and point out which aspects of them are emphasized as important by practicing teachers. In fact, Barnett and Hodson (2001) emphasize that their model is not a finished product, but will be refined as they continue to understand what teachers do and say. By gaining greater understanding of the roles teachers take and their holistic notions of teaching, teacher education programs should be able to better design pre-service experiences that maximize those aspects of teaching highlighted by experienced educators.

**Research Questions**

This research is a portion of a larger study conducted within the context of a site-based Secondary Science Methods and Curriculum course guided by a cognitive apprenticeship model. To further provide information to make this site-based experience valuable for those enrolled, a research agenda was set to better understand the beliefs and actions of the participating in-service teachers. Within the context of this site-based
methods course, a broad study was conducted to answer the following research question: What are secondary science teachers’ beliefs about science teaching and learning? Additional research questions included: (a) How do these teachers describe and define through models their beliefs regarding science teaching and learning? (b) How are their beliefs expressed in their professional practice? and (c) How does the teachers' participation as mentors in a field-based methods course influence their thinking about science teaching and learning?

This individual piece of the study focuses more narrowly on the above questions. In particular, this research sought to answer the following questions:

(a) How do science teachers describe and define through models their beliefs regarding science teaching and learning?
(b) How do these models relate to theoretical knowledge bases previously described in the research literature, specifically those of Barnett and Hodson (2001)?
(c) How does the teachers' participation as mentors in a field-based methods course influence their thinking about science teaching and learning?

**Methods**

In order to answer these research questions, a case study approach, guided by an interpretive qualitative methodology was used (Merriam, 1998). Theoretical frameworks of both cognitive constructivism and sociocultural perspectives directed both the design and collection of the larger data set. Constructivism can be thought of as a theory of knowing where an individual’s knowledge is built through experiences in the world (von
Glasersfeld, 1989). A knowledge base is valued by its usefulness more than its ‘truthfulness’. Because of this, the idea that different teachers would have different representations of teaching steered the research. The participant in-service teachers had different backgrounds in education and teaching. These experiences shape the way that they view their profession and their role as a teacher. Additionally, a sociocultural perspective takes into account other influences on teaching and learning (Gergen, 1995). The structures imposed by the school setting and the discipline of science likely share in some influence on the beliefs and actions of those in the school (Eisenhart, Finkel, & Marion, 1996). This research sought to use these frameworks to interpret the various models about teaching held by the participants.

Data Collection

A prominent feature of many case studies is the use of interviews and observations (Merriam, 1998), and these are the main sources of data for the study. With this particular piece of the research, interview data served as the principle source for analysis. Prior to engaging in research interviews, these six teachers (four female, two male) received a set of directions that were to be completed prior to beginning our interviews. The task (Appendix A) asked each science teacher to develop a diagrammatic model of teaching that would represent his or her holistic thoughts about the role of teaching and being a teacher. The purpose of this task was to let these participants reflect about their beliefs about teaching without any preconceived researcher bias entering into play. For example, I hoped to discuss a number of topics related to science teaching with these participants (assessment, classroom management, curriculum, etc.), but I hoped that providing the opportunity to develop a model would allow each participant to share their
beliefs about teaching instead of my beliefs about teaching. It was likely that participant and researcher beliefs would overlap to some degree, but I felt it was important to develop a method that would give the participants as much voice as possible in presenting their beliefs about their role as a teacher in the classroom.

The use of diagrams, drawings, or teacher-generated models does not seem to be an oft-used source of gathering information. Most educational research using this data source seems to draw on the production or use of drawings by teachers or students (Adler, 1982; Jolly, Zhi, & Thomas, 1998; Weber & Mitchell, 1996). Other researchers have used images as a prompt to analyze teacher identity (Ben-Peretz, Mendelson, & Kron, 2003). Regardless of the small, but growing, use of images and drawings in research, a strong rationale for their use has been proposed as a means to question previously neglected research areas (Fischman, 2001).

In particular, the development of these artifacts is related to the concept of “mental models”. Banquero (as cited in Greca & Moreira, 2000) explained what types of knowledge or beliefs are ascertained through the use of such models:

…a type of knowledge representation which is implicit, incomplete, imprecise, incoherent with normative knowledge in various domains, but it is a useful one, since it results in a powerful explicative and predictive tool for the interaction of subjects with the world, and a dependable source of knowledge, for it comes from the subjects’ own perceptive and manipulative experience with this world. (p. 12)
Mental models are functional for those who construct them and assists in making predictions and an understanding of whatever system is represented by the model (Norman, 1983).

After teachers developed their models, each was allowed the opportunity to explain them. This portion of the interview was open-ended, with only small interjections from the researcher for further clarification of concepts within their models. An exit interview was conducted at the end of the academic semester. Among the questions included in that session was an opportunity for the teachers to talk about their experiences as a participant in a site-based methods course and how it might have had an effect on them as a teacher. In particular, each participant was given the following four prompts: (1) Tell me your thoughts about the methods and curriculum class that was here; (2) What, if any, effect has this class had on how you teach or think of teaching? (3) Tell me about the experience of working with the student(s); and (4) Do you feel like your participation makes you feel more valued as a teacher in your contribution to teacher education? Teacher-developed models were re-created using computer capabilities in order to improve the neatness and readability of each. These have been made to represent the original model of each teacher in style and format. All interviews were audiotaped and transcribed for research purposes.

**Data Analysis**

The data presented below is given in such a way to provide as much voice as possible for the participant teachers. Each teacher’s model is presented along with a brief biographical sketch. The goal of this presentation is to let the participant tell how he or she thinks holistically about teaching and being a teacher.
Following these descriptions, the models and words of the six teachers are analyzed based upon the theoretical knowledge bases developed by and Barnett and Hodson (2001). Using the descriptions provided by those researchers, the interview descriptions of the models were coded to match the categories of knowledge bases from the literature. This has been referred to as “open coding” (Strauss & Corbin, 1990), where transcripts are read with sentences and paragraphs given various labels based on ideas, beliefs, or aspects of teaching represented by the words of the participants. Finally, the interview transcripts from the exit interviews were coded for comparison with the concepts of teaching presented in the teachers’ models. This open coding showed the connections between the models developed at the beginning of the semester and the influence of partnering in a site-based Methods and Curriculum course.

A Note about ‘Beliefs’ and ‘Knowledge’

In using the research methods described above, it should be noted that the analytical framework taken from Barnett and Hodson (2001) uses the phrase “Teacher Knowledge” while most of the discussion about the models and interviews with the participants refers to the concept of “belief”. While this article supports Richardson’s (1996) claims that beliefs are psychologically held understandings, premises, or propositions about the world that are felt to be true, it also recognizes Cobern’s (2000) acknowledgement of the blurry boundary between what is considered “knowledge” and what is considered “belief”. Cobern (2000) refers to the philosophers of science, Quine and Ullian (1978), who categorize “knowledge” as being in a subcategory of “belief”. The distinction between the two lies in the correctness of the belief.
Within the research presented from Springfield High School it was not the intent to ascertain whether or not the beliefs spoken by the participants were correct in their factuality in applying the analytical framework developed by Barnett and Hodson (which uses the term ‘knowledge). From this perspective, it should be understood that in applying an area of their framework, such as classroom knowledge, my article does not intend to convey that the participants had factual knowledge about the psychological and sociological aspects of their students. Rather, here it is intended that the participant science teachers had beliefs about particular aspects of classroom knowledge and it was these beliefs that served as the basis of analysis.

Models of Teaching Science

Participants and Setting

The participant in-service teachers in this research were selected based upon their partnership as a mentor teacher for a site-based Secondary Science Methods and Curriculum course. Although some of the teachers had previously worked with student teachers, none had ever been extensively involved with pre-service teachers who were in their first semester of teacher education courses. The six participants (four female, two male) ranged from five to over thirty years in teaching experience, with all having been at their particular school during the previous five years (see Table 2.3 for a summary of these teachers). The school, Springfield High, had a growing enrollment of about 1200 students in grades 9-12. The school served a community of students that live in a largely rural area, although it appears that growth from surrounding areas will transform this into
Table 2.3
Profiles of Participant Science Teachers at Springfield

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Education (B.S)</th>
<th>Years of Teaching</th>
<th>Class Observed</th>
<th>Student(s) in Course</th>
<th>Class Size</th>
<th>Other Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ms. Gumble</td>
<td>Chemistry M.Ed. Science Education</td>
<td>33</td>
<td>Chemistry</td>
<td>College-bound 11&lt;sup&gt;th&lt;/sup&gt; Grader</td>
<td>20-24</td>
<td>None</td>
</tr>
<tr>
<td>Ms. Quimby</td>
<td>Biology M.Ed. Science Education</td>
<td>21</td>
<td>Ecology</td>
<td>Vocational-Track 11/12&lt;sup&gt;th&lt;/sup&gt; Grader; Special Education</td>
<td>15-20</td>
<td>Human Anatomy &amp; Physiology</td>
</tr>
<tr>
<td>Ms. Flanders</td>
<td>Horticulture Additional coursework in Science Education</td>
<td>11</td>
<td>Gifted Physical Science</td>
<td>Top 9&lt;sup&gt;th&lt;/sup&gt; Graders</td>
<td>20-24</td>
<td>Physical Science</td>
</tr>
<tr>
<td>Mr. Hibbert</td>
<td>Zoology M.Ed. Science Education</td>
<td>18</td>
<td>Biology</td>
<td>All variety 10&lt;sup&gt;th&lt;/sup&gt; Graders</td>
<td>24-26</td>
<td>A.P. Biology</td>
</tr>
<tr>
<td>Mr. Burns</td>
<td>Science Education</td>
<td>5</td>
<td>Academy Physical Science</td>
<td>9&lt;sup&gt;th&lt;/sup&gt; Graders with Past Academic Problems</td>
<td>15-20</td>
<td>None</td>
</tr>
<tr>
<td>Ms. Botz</td>
<td>Science Education</td>
<td>10</td>
<td>Physical Science</td>
<td>“Middle-of-the-Road” 9&lt;sup&gt;th&lt;/sup&gt; Graders</td>
<td>18-24</td>
<td>None</td>
</tr>
</tbody>
</table>
a more suburban community within the coming years. The school was largely composed of students from two different racial groups, with White students making up the majority (60%) and African-American students the largest minority (35%). The school included a small number of Hispanic and Asian students, though the numbers of these students has grown recently. Income levels were on par with much of the state as about 40% of the students were eligible for free and reduced priced lunches. Scores by students on statewide high-stakes tests have historically been slightly below the state average. (Georgia Department of Education, n.d.)

Ms. Gumble. In her 33rd year of teaching, Ms. Gumble has a wealth of experience in teaching science at several different schools. Her undergraduate degree is in Chemistry, the subject she most often teaches. These classes are generally filled with college-bound 11th grade students, and her emphasis with these classes very often is in preparing them for success at the university level after their graduation. During the time of the study, Ms. Gumble (who lives in the community) was the mother of a child in one of her classes. Because of this, she was very knowledgeable on a personal level about many of the students in her classes. Her teaching style was largely a type of interactive lecture, supplemented by frequent trips to the chemistry laboratory (from Field Notes). In addition to having her students learn chemistry, interviews suggested that one of her biggest goals was to get her students to become more independent in different aspects of schooling (problem-solving, note-taking, studying, etc.).

The model presented by Ms. Gumble depicted a figure of herself as a teacher (Figure 2.1). With this diagram, she pointed to a variety of body parts and showed
Figure 2.1

Model of Science Teaching Developed by Ms. Gumble
My Teaching Model

**Imparts knowledge**

**Listens to parents**

**Listens to students problems (academic and personal)**

**Supplies a friendly face**

**Questions, instructs, and modifies student behavior**

**Checks on students' progress in class**

1. grades papers
2. prepares tests, activities, lab experiences
3. keeps e-mail up to date
4. prepares reports for administrators

**Patrols halls, bathrooms, alley**

1. keeps an orderly room
2. supports student athletic events
3. nurses cuts and burns
how each contributed to being a teacher. Beginning at the top, she indicated that her head was used to “impart knowledge”. In describing this aspect of teaching, she implied the continual need to learn about her subject matter because “you have to keep your brain active” (Interview 9/7). The second part of the head that was of use was her ears as she listened to both students and parents. Although the academic needs of students were important to her, she also stressed the need to listen to personal aspects of their lives:

…you have to listen to the students’ problems, and it’s not just school problems, its sometimes other problems that you really don’t want to know about, but if they feel like they’re comfortable talking to you, sometimes they just need to talk.

(Interview 9/7)

Lastly, the mouth was used for a variety of purposes, most notably for communication and the expression of emotion to her students. Supplying a friendly face for the students was paramount in her beliefs about being a teacher:

I thought that I would start with …a nice smiling, grinning face to make kids feel good about themselves, have a bubbling personality…so they really want to get into that science…you can’t expect the kids to be enthused if you can’t feel that smile on your face. (Interview 9/7)

Ms. Gumble stressed how emotions are important in the classroom through an anecdote about one particular class perceiving that they disappointed her by not being prepared for
a lesson: “They don’t want me to show my displeasure with them because I guess they feel disappointed in themselves. So, I guess that makes you feel good that what you think about them is important to them” (Interview 9/7).

The hands of Ms. Gumble were used for a variety of non-instructional tasks that comprised a great deal of being a teacher. She must grade papers to give feedback to students, plan for the coming class sessions, deal with administrative tasks and correspondence, keep her room and materials in order, support students in extracurricular activities, and deal with cuts and burns from laboratory sessions. In describing this aspect of her model, Ms. Gumble sarcastically joked that these parts of teaching are “all of those things that you have to do that take up very little of your time” (Interview 9/7).

Finally, Ms. Gumble pointed to her feet as she has to move around the class and monitor her students’ progress in the class. Along with her mouth and her hands, this was the third area of the body that she indicated use in order to get some type of feedback from students in a variety of ways. The last part of being a teacher according to her model involved her time spent making sure that the school outside of her classroom was orderly. She indicated specific duties, such as patrolling the hall or the parking lot, that were typical experiences in her job as a teacher.

Ms. Quimby. Like several other teachers in the department, Ms. Quimby came to science teaching after receiving her degree in science. In her 21st year of teaching, she described a life history and love for being outdoors and environmental issues. With a biology degree and background, her assigned classes are typically Human Anatomy & Physiology, Ecology, and Biology. Because of these course assignments, Ms. Quimby worked with a wide range of students in terms of their characteristics and academic
achievement. For example, the students in her Human Anatomy & Physiology classes were generally college-bound, while those enrolled in Ecology were often headed toward a vocational career after high school. In addition, the Ecology class is a special education inclusion class that uses a model of co-teaching with Ms. Quimby working along side a special education teacher in the class. Ms. Quimby also had a child attending Springfield, lived in the community, and felt a close tie to many of the students she teaches.

The approach to creating a model of teaching for Ms. Quimby was to describe science teaching as a composite of several different roles (Figure 2.2). These five roles were needed to effectively complete the complex goals and ends of her job as a science teacher. In bouncing around between being a facilitator, instructor, mother, secretary, and disciplinarian, Ms. Quimby seemed to view the role of a teacher as being extremely multi-faceted.

Two of the categories, facilitator and instructor related most directly to her interactions with students as she tried to accomplish the completion of curricular objectives. The differentiation between these two was in the degree of involvement she took in student learning:

The instructor, mainly (I’m) talking about teacher-centered activities and those kinds of things. Of course, there is the other side of that in writing lesson plans and researching new ideas and implementing those lesson plans. As far as, I consider myself in the classroom an instructor about 25% of the time. I see myself as a facilitator more where I have come up with ideas that will get them
Figure 2.2

Model of Science Teaching Developed by Ms. Quimby
interested, get the focus on them. I’m trying to lead them through the activity more. (Interview 9/4)

Though her distinction was not totally clear, it was apparent from spending time in the classroom that she was contrasting a teacher-centered view of instruction with a student-centered view of instruction (from Field Notes).

These two roles were played out both during and between class periods. During class, she had to present and guide students through activities, monitor and analyze progress, keep students on task, and encourage good work ethics that students demonstrate. Being a teacher involved substantially more than the time she interacted with students. Outside of class, for example, she had to write out lesson plans and research new ideas or lessons. This juggling of roles was further complicated by the wide-ranging characteristics of her students:

I have a student in Human Anatomy right now that has had Physical Science, Biology, AP Biology, and Chemistry and is back in here for Human Anatomy. And I also have another student in there who has barely passed Physical Science and barely passed Biology and is having this class as his third requirement. You know, with such vast differences, if this student over here gets through in 15 minutes - who has been through every other science course there is here- you know I’m probably not going to jump down his throat and make them do something else as quickly as I would perhaps with a student who I know really
has a long way to go – making sure that they stay on task and stay a little more focused (Interview 9/4).

As Ms. Quimby structured class to allow students to work in a student-centered environment, she realized that some students “get it” more quickly and more easily than others. For those students who have difficulty in grasping concepts, she needed to move into the role of instructor in order to teach and re-teach material to students. The fact that she used the phrase “teaching, re-teaching, and re-teaching again” seemed to indicate that her vast experience as a science teacher led her to accept the difficulty that students sometimes had in understanding scientific concepts.

A third role of being a mother seemed to lurk in the background regardless of whether she was a facilitator or instructor with her students. As previously mentioned, Ms. Quimby was a mother and felt that this influenced her interactions with students:

I think that so many students are coming through - I know so many of them and their personal situations because of my daughter. I’m probably a lot more likely on some of them to go, ‘OK – you know that you’re supposed to be doing this, this, and this. You know you really need to be studying more.’ (Interview 9/4)

Ms. Quimby indicated that the motherly part of her personality was “an important part of who (she was) as a teacher” (Interview 9/4). The aspects of this role indicated on the model were loving, encouraging, guiding, and being kind.
This motherly role also seemed to impact somewhat upon her role of being a disciplinarian. Though she mentioned a variety of items associated with this role, her personal characteristics often guided the way she deals with students in her classes:

I’m not a ‘you must sit up straight, put your feet on the floor, and don’t you dare speak’ kind of teacher. I’ve never been that way….I’m a peacemaker, a diffuser, not one that really likes to - I don’t cause a scene. Anytime that I discipline my students I try every way to get it diffused before it comes to a head. I take them out into the hall. I quietly say things to them. I think it’s a good thing – that’s the way it needs to be, but it’s not always effective. (Interview 9/4)

Ms. Quimby tried to be proactive with her discipline, supported by the fact that she included “encouraging good student behavior” as a part of that role. She had to wear the hat of disciplinarian outside of the classroom when she met with parents and students during conferences. She additionally indicated the need to know and follow the larger school rules found in the discipline and dress codes.

Finally, Ms. Quimby attributed a significant amount of being a teacher to the role of secretary. Making phone calls, writing reports, grading papers, and making copies significantly occupied a place in her beliefs about being a teacher. These areas tended to produce a sense of frustration, as they were perceived to keep her away from concentrating on the other parts of being a teacher:
If we had a copy machine in the department - if we had an aide in the department.

Of course, you see my elaborate room here (sarcastically). I’m constantly hauling stuff back and forth to the stockroom. In fact, I have a whole sink of beakers in there that I’ve got to get in there and wash. (Interview 9/5)

All of these “secretarial” tasks, in addition to working with students in the classroom, were essential to the job of being a science teacher.

Ms. Flanders. Of the six participants in the study, Ms. Flanders differed the most from the others in terms of her background. Beginning with her educational background, her undergraduate degree was in horticulture, and she received her teaching certification several years after completing that program. She grew up in the upper Midwestern United States and has lived in a number of states as well as in Puerto Rico. Now in her eleventh year of teaching, the fifth at Springfield, she generally taught Physical Science courses to freshmen. A new wrinkle in her classes was added this year as the school developed two “gifted” sections of the Physical Science courses based on academic criteria. Previously, there was a mixture of all abilities in her classes, but now this stratification had changed the complexion of these classes.

The model of teaching created by Ms. Flanders was like none of the others (Figure 2.3). She described the task of creating a model as being difficult because teaching is very “open-ended” (Interview 9/2). Her choice for showing what goes into being a teacher was represented through the creation of a classified advertisement that might appear in a newspaper. In developing this model, she focused on three main areas
that are needed by a high school science teacher: (1) educational requirements; (2) personality characteristics; and (3) abilities.

Though she included an educational requirement in the model, her discussion does not elaborate on it. It seemed that having completed some degree in science is sufficient. The aspects of the model that were discussed more in-depth during the interview centered on personality aspects. In her “Must Be” section, there were 22 different terms/phrases (23 if ‘flexible’ and ‘extremely flexible’ are differentiated) relating to descriptors of personal characteristics. The greatest chunk of these (understanding, kind, sympathetic, strict, lenient, fair, honest, and caring) seemed to most directly relate to the interpersonal characteristics that a teacher needs to have in order to be able to successfully interact with students. Much of this stemmed from her belief that a major part of being a teacher was to meet non-academic needs of students, such as caring about them: “I think in this environment you’ve got to care, otherwise – it’s just, we need that. Until these kids get out and on their own, I kind of feel like we’re taking care of them” (Interview 9/2).

Additional characteristics seemed to refer to aspects pertaining to youth. Along with the term ‘youthful’, she presented other adjectives that tend to conjure up ‘young’ images, such as ‘energetic’, ‘outgoing’, and ‘entertaining’. Apparent inconsistencies were included with antonymic pairs of words, such as ‘strict/lenient’ and ‘funny/serious’. When asked about this, Ms. Flanders clarified by providing specific instances of classroom interactions:
Figure 2.3

Model of Science Teaching Developed by Ms. Flanders
Model of a Science Teacher

Classified Section of a Newspaper

Wanted:
High School Science Teacher

**Educational requirements:** Must have at least a Bachelor’s Degree in Science

**Salary:** Commensurate with experience and education

**Must Be:** extremely flexible, understanding, kind, flexible, youthful, energetic, sympathetic, outgoing, willing to learn, organized, entertaining, adaptable, thrifty, strict, lenient, funny, serious, fair, open-minded, honest, caring, creative, and optimistic about the future.

**Must be able to:** multi-task, lend a shoulder to cry on, live on limited funds, counsel worried soul, determine future events, work as a team member, interpret generational languages, not take yourself too seriously.
Well, some things you can’t compromise and some things you’ve got to kind of give them a break. Like Jack, who was tardy today because he was putting his contact in - well, I could have made him go get a pass. He probably would get ISS (In-school suspension) now- he’s been tardy so many times. But I know that he was really in there, so sometimes its just like ‘Get in here’. Or actually, sometimes using of foul language. Kids will drop something and say the wrong word. Well, you can write them up, but what’s the point? They’re not going to learn more. Sometimes people slip up. But if you get up and say, ‘I don’t give a what about you’, then he’d be gone, you know. So, I just think you have to know when to let it go. (Interview 9/2)

These characteristics of being both strict and lenient were dependent upon context. With certain cases, Ms. Flanders was unwavering in her expectations for student behavior (such as laboratory safety – from Field Notes), but could be more permissive with others (as described above). Implicit in her words from the end of the last passage was a return to the need to show care and concern about her students. It seemed to her that rules and consequences should be used to change behavior and sometimes she used personal judgment to permit exceptions to rules. From observations of her classes, her allowance of leniency was the exception more so than the rule (from Field Notes).

The personal characteristics Ms. Flanders shared in the ‘Must Be’ section seem to be a prerequisite for the items listed in the ‘Must be able to’ section. Those above-mentioned characteristics focused on caring and youthfulness are needed so that the teacher was able to ‘lend a shoulder to cry on’, ‘counsel worried souls’, and ‘interpret
generational languages’. This last phrase implicitly pointed out the communication
differences found between student and teacher. Thus, teachers who kept these younger
characteristics might better be able to relate and interact with their students.

Additionally, other aspects of teaching were made clear from her descriptions.
Being able to ‘multi-task’ implied a lack of time to thoroughly work on a number of
different jobs. This related back to the earlier described characteristics of being
‘organized’. Teachers have to ‘live on limited funds’ and must be ‘thrifty’. This was
especially true for teachers like Ms. Flanders who were unmarried and not supplementing
their income with the earnings of a spouse. The ability to ‘work as a team member’ was
a requirement as teachers share committee membership and responsibilities for planning
the teaching of specific courses. During the term of this research, Ms. Flanders was
involved in several committees, one of which was attempting to align science teaching
across grades levels from elementary to high school (from informal discussion).

A last ‘must’ that was described by Ms. Flanders related to the overall need for
keeping a positive attitude in teaching. In particular, she used the terms ‘open-minded’
and ‘optimistic’ in describing characteristics and concluded her advertisement by
indicating that teachers should ‘not take yourself too seriously’. Several times during our
interviews she referenced someone outside of education who either spoke poorly of
public schools or the students that she teaches. One particular excerpt pointed out the
need to remain optimistic:

This is real important too, (being) optimistic about the future. A lot of people are
like, ‘Kids today -blah, blah, blah.’ And, I think there is a lot of weird stuff, but if
you aren’t optimistic, what’s the point? Just like our parents thought about us.

(Interview 9/2)

She recognized that history seems full of examples of adults showing disapproval for the choices and actions of teens. Being around high school students provided Ms. Flanders with a reality about adolescents often missed by adults outside of education. When asked if she thought she was more optimistic because of being around kids all of the time, her briefs response was, “Definitely. You bet” (Interview 9/2).

In relating this description to her own teaching, Ms. Flanders stated, “I feel like I do all of that (the descriptions in her model), maybe not very well. But you know, I feel like at some point that I’ve done that, or do do that” (Interview 9/2). Ms. Flanders presented a description of being a science teacher based much more on aspects of personality than areas of pedagogical expertise. There seemed to be a bigger picture to her than simply being able to present scientific information in a way that is easy for her students to understand. She contrasted the caring teacher with the college professor:

Just think about college where you had some really crummy professors who didn’t really care, I guess. They didn’t really try to help you understand it. But, I guess a lot of professors don’t really care; they’re just going to lecture anyway. You get it or not. Who cares? (Interview 9/2)

Thus, one can have a great deal of content knowledge, but teachers lacking the characteristics of care were not able to make sure their students are able to understand the
material. Being emotionally supportive for her students and portraying a positive attitude in the classroom seemed essential in being a good science teacher.

Mr. Hibbert. In his 18th year of teaching, Mr. Hibbert has spent his entire professional career at Springfield. He holds a B.S. in Zoology as an undergraduate with a Master’s degree in Science Education. He almost always had Biology and A.P. Biology classes. Mr. Hibbert was very laid back and soft-spoken with his students, but discipline problems were few and far between (from Field Notes). His interactions with the students seemed to communicate a great deal of concern about them as individuals in addition to them as students. Like the other teachers in this study, he had a very good knowledge of the science content and presented things in a variety of ways to his students. Class time for his Biology students was spent in a number of hands-on activities, review games, traditional notes, and independent seatwork (from Field Notes). The teaching model presented by Mr. Hibbert seemed to take on the form of an energy system (Figure 2.4). In describing its overall appearance, he said, “It's just kind of a flow. I call it a flow of energy” (Interview 8/27). Within this flow were located five main boxes that are circled, with arrows leading back and forth between these main concepts, influencing one another in a variety of ways. For Mr. Hibbert, a model of teaching and his role of being a teacher was quite broad. Interestingly enough, the teacher is only a small part of the larger picture, with components of parents, student, curriculum, and evaluation each occupying a place in the model.

Despite these five main concepts, Mr. Hibbert did not give each equal weight within the model. “The main focus here is between the teachers and the student” (Interview 8/27). This dynamic between student and teacher was highlighted by four
Figure 2.4

Models of Science Teaching Developed by Mr. Hibbert
Teaching Model

Evaluation

Parent(s)

Encouragement and support

Student

Feedback to teacher

Curriculum

Alteration for learning styles

Teacher

Evaluation by administration

Feedback & response

Seeking help with student

tests

advice

support

teaching

adaptation

Becoming familiar

= input
arrows showing how each influence one another. The teacher was there to support, advise, and actually teach the student, while the student was able to provide feedback and responses to the teacher. This feedback influences the cycling of interaction, as the teacher was able to gauge student understanding. This part of the model was largely informal, as noted when Mr. Hibbert said, “You can look at the students’ face sometimes and tell if they're learning” (Interview 8/27).

The student also was influenced by parents’ encouragement and support. From his teaching experience, Mr. Hibbert noted than many students did not receive much input from this aspect of the model:

Parents - I think their only role is to encourage and help, and do some tutoring. Unfortunately, in our semi low-income county we don't have a lot of parent involvement. And, we do on the students who are very bright and doing well, but the ones who really need it really don't get it. And that's probably why they need it and why they're not doing well. (Interview 8/27)

Later in the interview, Mr. Hibbert related a couple of stories describing the difficulty in getting parents to become more involved in their child’s education. For example, he estimated that their open house at the school only has about a four or five percent turnout by parents. Alarmingly, he also related the story of a parent who likely did not provide the encouragement and student support that Mr. Hibbert indicated on his model:
I called up one parent once at 9:30. He was real groggy, I woke him up. I was talking to him telling him all about the student, and he started snoring on the phone and I just hung up. He just fell asleep on me. (Interview 8/27)

Thus, the strength of the arrow between ‘Parent’ and ‘Student’ likely mirrored the strength of the feedback loop that ran between ‘Parent’ and ‘Teacher’. Parents who provided little support for their students would not seem likely to provide very much feedback for the teacher.

Another main area of the model of teaching was curriculum. Since students had to learn some specific content, the curriculum was important because it “drives what you are going to teach” (Interview 8/27). However, the curriculum was not a static entity. According to Mr. Hibbert, teachers needed to develop a familiarity with the curriculum and understand the material so “they're not teaching things that are wrong” (Interview 8/27). Additionally, teachers adapt their curriculum for a variety of reasons. Some teachers tended to like certain areas of the curriculum more than others:

Teachers also have to adapt the curriculum to their interests. If, you know, if you have a teacher who can't stand ecology and doesn't know anything about it and hates it, then maybe they should spend a week on it and move on. Whereas, I love Ecology and spend two weeks on it. (Interview 8/27)

Lastly, the curriculum may need to be altered depending upon the characteristics of the students in the class. Like many of the other science teachers, Mr. Hibbert worked with
students in special education who were included with the “regular education” science students. In these circumstances, the curricular material may need to be presented in a different way depending upon the needs and learning styles of the student.

The fifth aspect of Mr. Hibbert’s model involved evaluation, for both students and teachers. For students, evaluation involved formal testing and the questioning that was typical of student-teacher interaction. In understanding the job of teaching, evaluation of the teacher by administrators was also important. During his explanation of the model, these parts of the model were not explained in any detail.

Despite his ethic of caring displayed in class and in later interviews, Mr. Hibbert did not explicitly include the types of emotional support in his model that was evident in the models of Ms. Quimby, Ms. Flanders, and Ms. Gumble. For Mr. Hibbert, it seemed that the various parts of teaching largely involved all of those things he feels that influenced student learning. In fact, one of the first things he said in beginning an explanation of his model was that he had “the student of course in the center of education, which is the whole reason we're here” (Interview 8/27). Thus, his role in being a teacher was dominated by coordinating the various inputs that influence this central aspect of his model.

Mr. Burns. Mr. Burns was the youngest and most inexperienced of the science teachers in the study. He has spent all five of his years teaching at Springfield, largely working with 9th Grade Physical Science students and 10th grade Biology. This particular year was quite different from those in the past due to a change in how students were assigned to Physical Science classes. Students who were identified (from past academic problems and low test scores) to be at risk for doing poorly in science classes were placed
into a yearlong course. The rationale was that the course could progress slower than the
typical one-semester class on the 4x4 block schedule. It was to these classes that Mr.
Burns was assigned as teacher, facing him with discipline and management problems that
were more severe than in the past. New to having these students, he was often frustrated
by the mismatch between his own preferred style of classroom interaction (a more laid
back approach) and the behaviors of his students (which warranted a stricter approach)
(Field Notes & Interviews).

The model developed by Mr. Burns (Figure 2.5) showed that teaching is made up
of four subcategories: classroom management, curriculum development, extracurricular
activities, and teacher-student relationships. In describing these various parts of being a
teacher, it was clear that Mr. Burns recognized that a great deal of the job was spent away
from interaction with students in the classroom. Of his four boxes underneath Teaching,
only two related directly to his job teaching science (classroom management and teacher-
student relationships). The other two (curriculum development and extracurricular
activities) related more to additional responsibilities that teachers have in their job.

As a part of the act of teaching, classroom management played a significant role
for Mr. Burns. This may have been because of the students that he had during the study
and the frustrations felt compared with previous years. Nevertheless, he viewed
classroom management as something that needs to be consistent with one’s own
personality:
Figure 2.5

Model of Teaching Developed by Mr. Burns
Your first year you kind of develop that style. But after a year or two you should kind of develop who you are, and if you try to be someone else you will probably put a lot of extra stress on yourself. You can make your style work. So, figure out what you like and what you are good at and make that work. (Interview 8/29)

Mr. Burns indicated that teachers have to have a comfort level in how they interact with their students in terms of discipline. Though he often felt the need to be stricter in his classroom with these younger, low-motivated students, it was difficult for him to move in that direction:

If I came in here and I tried to be extremely strict – everybody’s going to sit down- I can’t do it. I don’t. I can’t do it. So, yes I am going to modify it on the needs of the class, but I am still me and my classroom is going to be a little more laid back. (Interview 8/29)

He also saw the need to have different classroom management depending upon the students that he has. Despite his personality preference, some students needed a little more structure than others. He attributed this somewhat to the characteristics of students in different classes based on his previous experiences:

They (10th graders) are more mature, and the big difference is that you don’t have all of the - everybody that is in the 10th grade Biology class passed Physical Science with a passing grade. So they have - not that they are good students, but
you don’t have the real bottom of the barrel people who are here just to get out of the house. So, you knock out the bottom 25% of the people who give you problems, for the most part. It’s a big difference between the 9th and 10th grade. I found biology much easier and more enjoyable to teach. (Interview 8/29)

The older students he had previously taught presented a classroom environment that was more aligned with his preferred style of classroom management. These “bottom of the barrel” students he had in Physical Science during the study gave much more of a challenge, forcing him to attempt to enact more structure than he found comfortable. These recent experiences also influenced his last area of description about classroom management. He pointed out that it was important to be consistent and follow through in areas of classroom management, something that became more apparent to him as he dealt with a great amount of off-task behavior in his classes:

I’ve learned that the hard way this year. I went through about a month or so where I didn’t follow through with my consequences, and now I’m going to have to turn over a new leaf and pick up some of those new rules again. And, it’s helping out a lot. (Interview 8/29)

In addition to classroom management, Mr. Burns felt that having relationships and being buddies with students was important for him as a teacher. He provided several beneficial reasons for having a positive relationship with students:
The relationships make my job more fun, for one thing. I enjoy relationships with the teenagers. So, that’s a benefit for me. Hopefully, the benefit for them is that if they think I’m cool, or whatever you want to call it, they will hopefully listen to me in class when I’m trying to teach, or they will respect what I say or my opinion or when I say something is important. I think kind of being buddies with them helps. (Interview 8/29)

A significant part of the enjoyment Mr. Burns derived from being a teacher came from being able to know his students in a more personal way. He liked to relate to them in their own terms, such as playing basketball with them or discussing car stereos. In addition to making his job more pleasurable, he felt that developing bonds with the students may cause them to more strongly heed his words as a teacher.

He also recognized that part of his role as a teacher was to be there for students when they needed someone with whom to talk and share their concerns about life. Being a good listener built trust, which gave further positive effects on his science instruction:

Be a good listener. High school students constantly have problems - boy problems, girl problems, home problems. And if you listen to them, it does a lot to build that relationship. It builds trust, and hopefully you can turn that around in the classroom if you have some of these students, and they will be more willing to listen to you. (Interview 9/9)
Again, he saw this aspect of teaching as important for him to help students become more open to learning in his classroom. Implicit in these quotations was the idea that having positive relationships with students may make classroom management a less-problematic enterprise.

Other important parts of being a teacher occurred outside of the setting and timeframe of a specific science class. The first of these was in what Mr. Burns terms curriculum development. Although teachers have textbooks and other materials provided by the school district, they may not be appropriate or relevant to the degree that the teacher would like. Because of this, the teacher has to spend time gathering supplements and resources to bring into the science classroom to provide a more meaningful experience for the students:

The textbooks that we have are pretty good, but in order to make it as relevant as possible it is nice to get out and talk to other teachers - get on the internet, check out some other resources that are going to hopefully bring it home for you a little more than what they give you in the book. As far as curriculum development, really I just mean supplementing what they have, adding to it, not really taking things away. Bring in some stuff that will hopefully get them to pay attention a little better, to take interest. (Interview 8/29)

Knowing his students, Mr. Burns tried to make his science teaching relevant to their lives. During lessons on machines, for instance, he brought in a videotape about the science behind automobile racing (from Field Notes 9/24).
In addition to all of this outside planning, Mr. Burns was faced with another challenge during the academic year. The school district had adopted new science textbooks over the summer, leaving Mr. Burns and the other teachers having to spend extra time becoming more familiar with their new materials. Although the content was largely the same, teachers had to alter the materials developed over the past years to better align with the new textbooks and supplementary materials. Because of this, Mr. Burns indicated that he’s “spending a lot more time than (he) did last year” (Interview 8/29) dealing with the changes in their textbook situation, especially in terms of the sequencing of topics.

Lastly, Mr. Burns recognized the importance for secondary teachers to be involved with extracurricular activities and the amount of time required in working with these. These extracurricular activities can be those that teachers largely chose to do (sports, clubs, etc.) or fall under the umbrella of activities that they had to do (school committees, duties, etc.). Because of personal circumstances, Mr. Burns had not worked with any sports or clubs during his five years of teaching, although he indicated that he would like to be able to do so in the future:

Clubs, sports, supporting athletes, etcetera. A lot of teachers are involved in that type of stuff in general, whether it’s coaching the cheerleading team or just going to the football games. At this point in my life, with two babies at home, I don’t do hardly any of that, and I don’t plan on it. I would love to change that when my kids are older. Coaching tennis, I think I would enjoy that a lot, and supporting the kids in whatever they’re doing, whether it’s the debate team or whatever. I
would enjoy doing that and showing that support to them. So, that’s a big part. It takes up tons of weekends and afternoons and stuff, so that’s a big part of a teacher’s life. Or it should be, if they can. (Interview 8/29)

Despite his inability to work in these extracurricular areas, Mr. Burns recognized the importance for teachers to work outside of the classroom. Teachers also had a role in providing support for students in these areas, even if the teachers were not directly involved with the activity.

A part of teaching that was indicated by Mr. Burns as taking up a great deal of time was in attending meetings and having other assigned duties. These things always occurred outside of instructional time and tended to eat away at other areas of being a teacher, such as planning. Mr. Burns outlined the amount of extra obligations he has:

…keeping up with meetings, obligations, and duties. We have SST’s (Student Support Team meetings), we have break duty, we have morning duty, we have obligations to work as ticket collectors at games. We’ve got - you know, we’ve got a ton of stuff. You’ve got to have a calendar and keep up with it. All that stuff outside the classroom is big enough that it needs to be an important skill and is important to your teaching formula, or teaching plan. (Interview 8/29)

The teachers had to be involved in these additional roles in order to help meet many of the goals of the school and to help ensure order in common areas of the building. Sometimes this aspect of teaching became burdensome. In summing up this part of his
model, Mr. Burns related, “You are constantly asked to help out with this committee or that committee” (Interview 8/29).

Absent from the model presented here were any aspects of teaching that actually involved working with students to learn material. According to his model, the greatest parts of being a teacher for Mr. Burns were clustered in two different areas. The first of these two was dominated by building constructive relationships with students that will help to develop an orderly classroom. The second was found in the time spent getting lessons and materials ready for class in between all of the times required to work in committees, meetings, or other types of duties.

Ms. Botz. The sixth participant was Ms. Botz, who had ten years of teaching experience, including seven at this school. Her college background focused on chemistry as she was originally planning a career in pharmacy, but her primary teaching duties usually involved Physical Science with ninth graders. Ms. Botz was quite active in school affairs, serving as department chairperson and as the cheerleading coach. With the change in structure to the Physical Science classes, Ms. Botz’s classes were composed of the “average” student since those labeled as gifted were with Ms. Flanders and those “at-risk” were with Mr. Burns.

Though the six participant science teachers each developed somewhat unique models of teaching, Ms. Botz developed the simplest of all (Figure 2.6). Her representation of a model of teaching drew on metaphorical thinking, where she saw the role of a teacher to be a bridge for the student to get to the future. Interestingly, the teacher-as-bridge kept the student from falling into the troubled waters of parents. Ms.
Figure 2.6

Model of Teaching Developed by Ms. Botz
Teaching Model
Botz explained that sometimes parents had different goals for their children than what the child might have in mind:

Sometimes I view parents as troubled waters because sometimes their visions and students’ visions are two different things. And, sometimes parents, to me, get caught up in socio-patterns – we’re friends, and your kid is an ‘A+’ student, and maybe my student is not ‘A+’ material, but if they can do their best and earn B’s, then we have an option…. And usually the parents already have their agenda in mind, what they want for their kid. Sometimes you have to help the students convince the parent that this is what the kid wants. (Interview 9/2)

A source of influence in the development of her model likely was in her own past. During the course of the interview, Ms. Botz shared how her own parents pushed her to become a pharmacist, although she wanted to be a science teacher. In fact, she did not tell her parents of her switch from Pharmacy to Education until her college graduation. Now that Ms. Botz had become a parent, she saw how parents want to push children in a certain direction. However, her own experiences about choosing teaching against the wishes of her parents allowed her to empathize with the child’s point of view. This seemed to put her in a unique situation to mediate the conflicts she sees between parent and child:

Now that I have a child of my own, I can really see if from two different viewpoints. In my mind, my kid is only four, almost five – in my mind I envision
what he is going to be, or what I think he would like to be, or what I wish he would think about being. But, who knows how he is going to feel about school? So, it’s really hard because as a parent you really find yourself, even though you try so hard not to – when you’re in a circle of church, or whatever, and you hear someone say, ‘My son’s in law school’ or whatever, naturally you want to speak up and go, ‘Well, my kid is going to be President of the United States’. Then, as a teacher, you’re like, ‘Look, your kid wants to be a mechanic and that is what is going to make him happy.’ (Interview 9/2)

Ultimately, this last sentence seemed telling because it indicated that Ms. Botz looked at her job as working to make sure that her students had a future that allowed them to pursue something in which they have an interest.

As Ms. Botz tried to smooth over the expectations between students and parents, she also wanted her students to begin to think about their futures. Since she worked with the youngest of all the students in the high school, she believed they often do not think very far ahead about goals and choices in life:

But, the biggest job as a teacher is to get students over to the future part, whether it’s college, technical school, a job, Armed Forces – whatever they want to do. As long as you can make them realize that after they leave high school they have to do something, after high school is the real world. You’re either going to go to college, and you have something in mind when you go to college, or you’re not
going to go to college – you’re going to go to technical school. You have to have a game plan. (Interview 9/2)

Since 9th grade students “never see the big picture” (Interview 9/2), Ms. Botz framed her job as a teacher around getting the students to begin thinking about the potential in life and how school relates to their futures. Though the model provided by Ms. Botz is simple, it was very telling of how she identified as being a teacher. For her, the biggest part of the job was helping students to make it through to the future. In addition to the aspects she described in terms of speaking with parents, this also involved spending time with students before, during, and after class to help make sure they understand science content well enough to pass her course. However, she seemed to want her students to learn science not simply for the sake of better understanding the natural world, but to help them begin taking steps toward a future of their choosing.

Models within the Context of Theoretical Teachers’ Knowledge

Despite the wide variety of approaches used by these participant teachers in developing their models of teaching, each provided a great deal of insight about the beliefs held about being a science teacher. Some of the models were very much self-focused, such as the drawings by Ms. Gumble and Ms. Quimby. Others, like the charts of Mr. Burns and Mr. Hibbert, portrayed the broader aspects of education as interpreted from their own experiences in the classroom. However, in all cases we were presented with a visual image showing how each understands the role of the science teacher in the classroom.
The content of these models, along with the accompanying interview data where participants explained their models, can be analyzed by comparison with theoretical frameworks of teacher knowledge found in the literature. In comparing the models with the literature, it can be determined which aspects of teachers’ knowledge bases were most commonly found within the teachers’ models. In addition to better understanding how experienced science teachers viewed their roles and beliefs about teaching, implications concerning teacher education practices should become apparent from this comparison.

Shulman’s Knowledge Bases

Aspects of the seven knowledge bases of teachers outlined by Shulman (1987) can be found as a framework within many pieces of research (e.g., Feldman, 2002; Gatbonton, 1999; Lloyd & Smith, 1998). Through coding the models developed by the participants in terms of Shulman’s seven knowledge bases, a picture begins to develop that indicates which aspects of those beliefs about the knowledge bases are most relevant to these science teachers. For each participant, their model and interview relative to their model were coded and examined for evidence of each knowledge base.

An examination of these codes shows that the six participants varied considerably in terms of which knowledge bases were significant in their model of teaching. The first three areas of Shulman’s knowledge bases in the table were the most varied in terms of being featured in the models. Specific content features were mentioned by three of the teachers, but were absent in the other half. Likewise, general pedagogical knowledge and curriculum knowledge ranged from being significant in some cases to being absent in others.
The last four knowledge bases were mentioned more similarly across the teachers. **Pedagogical content knowledge** was the only area not mentioned in any extent by the teachers. Neither their models nor the interviews referred to anything concerned with making science content understandable through the use of specific methods and strategies. Similarly, **knowledge of education ends, purposes, and values** was not found in the majority of models. The major exception of this was found in the bridge metaphor used by Ms. Botz in explaining that her role was to help students achieve an end of moving to their future.

The two areas that were mentioned most significantly by the teachers were in the **knowledge of learners and their characteristics** and **knowledge of educational contexts**. Each of the teachers spoke about having personal relationships with students, listening to their problems, or empathizing with their home life. Almost as prevalent were descriptions of educational contexts. Items that would fit in this category included working in committees or with other teachers, giving descriptions of the community, and describing non-teaching duties (coaching, clubs, monitoring halls, etc.) that teachers had to do to help the school function.

**The Knowledge Landscape of Barnett and Hodson**

Barnett and Hodson (2001) present a somewhat different landscape of the components of science teachers' knowledge. Similar in many aspects to Shulman, their model differs in that it has four main areas of knowledge. In showing how these categories could be used in analyzing interview data, Barnett and Hodson (2001) indicate additional subcategories that work to make up each major category. The models and interviews of the six participants in this study were coded to fit the Barnett and Hodson.
For each participant, his or her model and subsequent interview were examined for evidence of the four knowledge bases. Specifically, the interview data where participants explained their models were coded using the knowledge base categories provided by Barnett and Hodson (2001). For the purposes of reporting the data, a final sum was tallied for each of the four main categories from the subcategories within each (Table 2.4).

From the participants’ models, academic and research knowledge did not constitute a great deal of their beliefs about being a teacher. Across the teachers, only small parts of this category were noted in their models (see Table 2.2 for the components of each category). Ms. Gumble, Mr. Hibbert, and Ms. Flanders each mention content knowledge in their models, although they do not elaborate on it as being significant. For example, Ms. Flanders lists the requirement for a science teacher to have a bachelor’s degree. In passing, Mr. Burns compares his relationships with students to other teachers (“The other teachers don’t have that” – Interview 8/29), inferring his use of other teachers’ experience. However, he provides hardly any other examples of items that would fall into these categories. Several of the teachers present their overall approach to developing the model as a personal philosophy. Taking all of this together, an explicit acknowledgement of using academic and research knowledge is all but absent in these teachers, except for the areas of scientific knowledge and having a personal philosophy of education.

As in the cursory examination of the teachers’ models using Shulman’s knowledge bases, these teachers barely mention anything regarding pedagogical content knowledge (PCK) as a part of their model of teaching. These teachers did not mention
Table 2.4

**Analysis of Science Teachers’ Models and Using Barnett & Hodson’s (2001) Components of Science Teachers’ Knowledge**

<table>
<thead>
<tr>
<th>Categories of Science Teachers’ Knowledge Subcategories</th>
<th>Ms. Gumble</th>
<th>Ms. Quimby</th>
<th>Ms. Flanders</th>
<th>Mr. Hibbert</th>
<th>Mr. Burns</th>
<th>Ms. Botz</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Academic and Research Knowledge (overall)</strong></td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><strong>Pedagogical Content Knowledge (overall)</strong></td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td><strong>Professional Knowledge (overall)</strong></td>
<td>10</td>
<td>8</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>3</td>
<td>34</td>
</tr>
<tr>
<td><strong>Classroom Knowledge (overall)</strong></td>
<td>8</td>
<td>19</td>
<td>5</td>
<td>7</td>
<td>13</td>
<td>5</td>
<td>57</td>
</tr>
</tbody>
</table>

Each number represents the number of instances a code within that category was assigned to a portion of the interview data concerning the model.
any specific ways of making their science content accessible and understandable for their students. In particular, on general aspects of using strategies or assessment were mentioned, but these were included in the tally since each teacher specifically taught a science subject. The only scientific resources mentioned were brief words about beakers, lab rooms, and textbooks. Aspects of assessment, grading, and evaluation were parts of several models, although none of these was specific to science.

The next category, professional knowledge, closely aligns with Shulman’s knowledge of education contexts, although there seems to be some difference between the two, such as the former including more novel aspects (i.e., teacher lore). Most of the teachers included aspects of the political and sociological knowledge of schooling, most frequently in the areas concerning the official duties of a teacher and relations with parents. Included in this subcategory were instances when teachers mentioned extracurricular duties and communication with administration, parents, and the community. Most also discussed the professional knowledge of education when discussing issues such as curriculum and planning.

Like Shulman’s knowledge of learners and their characteristics, the final category of classroom knowledge was the most prominent of the categories found in the Springfield science teachers’ models. Despite the varied approaches to creating the models, each of the teachers included numerous aspects about the sociological aspects of their students. Along with those, having knowledge of individual students was found across the board in the models and their explanations. Teachers related specific stories about past students from their classes to illustrate their beliefs about certain aspects of teaching. Additionally, several indicated the need to address the psychological needs of
their students as they often feel the need to provide “shoulders to cry on” as they listen to the problems voiced during informal conversations.

Discussion of Teacher Models within Theoretical Frameworks

Using the works about teacher knowledge bases in the literature by Shulman (1987) and Barnett and Hodson (2001) helps to clear up the emphases in the models of teaching created by the science teachers in the study. In both cases, specific categories of teacher knowledge were much more prominent than others. Of Shulman’s seven knowledge bases, the teachers in the study included only two such categories. Similarly, when using the Barnett and Hodson model as an analytical framework, two of the four major areas of teacher knowledge were found to dominate the participants’ models. In both cases, these two areas of knowledge focused on knowledge of students and the larger educational context of the school. Statements related to these areas were found to a much greater extent than areas of teacher knowledge concerning either science content or specific pedagogy. If these teachers’ models and interviews represented their beliefs about science teaching at their school, then they indicated which teacher knowledge bases seemed to be at the forefront of their everyday practice.

In particular, previous research supported how specific educational contexts may have an effect upon the identity of teachers (Ben-Peretz et al., 2003). These authors argue that teachers may draw upon the perceived needs of their students for a significant part how they see themselves as teachers. Each of the six teachers at Springfield had been working with similar students for a minimum of five years at that school. Since a great deal of these students were perceived as coming from poor backgrounds with unsupportive family structures, the teachers may have felt the need to offer more of
themselves in the area of emotional support than in academic support. This is not to say that the teachers, in their practice, did not emphasize the academic aspects of school science. On the contrary, most had high academic expectations of their students and seemed to possess a great deal of content knowledge in science (from Field Notes). In subsequent interviews, all (with the exception of Mr. Burns) pointed out that it was important to have a strong knowledge of science in order to teach effectively. Since this area of their beliefs was not elicited in their models, they were not included in the analysis.

A second study may help shed more light on the results from lack of content-related items noted in the teachers’ models. Beijaard, Verloop, and Vermunt (2000) reported that teachers seemed to experience a shift away from seeing themselves as a subject matter expert to more of a pedagogical or didactical expert as they spent more and more time in the classroom. Since all but one of the teachers in the study at Springfield had a minimum of ten years experience (Mr. Burns had five), perhaps certain aspects of experienced teachers’ knowledge become more implicit over time. For example, after teaching a certain unit in Biology for 18 years, the pedagogical and content aspects of the lesson likely became automatic. In contrast, the methods for motivating and dealing with student behavior are rarely foolproof, requiring teachers to expend a greater amount of mental energy developing knowledge about their students. Perhaps experienced teachers simply think and reflect more on their interactions with students than about how to present science content.

Subsequent interviews with these participants indicated a number of other issues that likely contributed to their work as a teacher. Some expressed views about how it
was important for them to be able to meet with and plan specific lesson or units with their colleagues within the science department. Others mentioned how the advent of high-stakes testing over the past few years significantly altered the way they went about teaching their specific science content. However, most of these other areas of teaching were discussed as a response to an interview prompt, differing significantly from the data collection used with the model. The freedom of reflection, with little input bias from the researcher, suggested that these experienced science teachers viewed being a science teacher in broad terms that focused more on interacting with students than in conveying content to them. Additionally, non-instructional aspects of the job, such as attending meetings, played a significant role in shaping the teachers’ beliefs about being a teacher. The emphasis on these areas over content suggested that becoming an experienced teacher involves a great deal more than mastering content knowledge, pedagogical knowledge, and pedagogical content knowledge.

**The Influence of Site-based Mentoring on Science Teaching**

In addition to examining the models created by experienced science teachers, additional interview data were examined to note how their participation in a site-based Secondary Science Methods and Curriculum course would impact their beliefs about being a science teacher. From working with teachers at previous schools in a similar setting, the professors of the course perceived a positive benefit in the science teachers mentoring the pre-service teachers.

Near the end of the semester, after the pre-service teachers’ involvement at the school ceased, an exit interview was conducted with each science teacher (Appendix D). A variety of open-ended questions were asked during the semi-structured interview,
several of which focused on their experience as a mentor and any effects it may have had on their teaching. For the most part, the teachers’ responses to these questions seemed to indicate their beliefs that the site-based course was much more beneficial for the pre-service teachers involved than it was for them. Several expressed how working closely with novices in their classroom altered the normal way they go about the business of teaching, but it did not seem that any significant transformations were made in how these teachers practiced or viewed being a science teacher. However, almost all indicated how their involvement made them feel more appreciated as a professional.

One idea that was quite common from the interviews was the response explaining how the site-based course was beneficial for the pre-service teacher. As a prompt, these teachers were asked to share their thoughts about the program in which they were involved. The focus of their thoughts indicated very little in the way of personal gain compared to what they viewed as invaluable experience for the pre-service teachers:

**Mr. Burns:** I think that for their (pre-service teachers) benefit that it was a really good idea. I wish there was something else like that when we were in place. Student teaching just kind of throws you into the wolves. This is just one more hands-on, practical way to get in there and do more teaching. The practicum, I didn’t think it allowed you to do much of that, so I’m in favor of it. (Interview 12/16)

**Ms. Quimby:** I think it’s priceless. I really think that experience is so much better than what I had on campus at the University. To be out in the classroom an
entire semester, shy of three weeks or whatever - an entire semester, in the classroom so much, I think that’s invaluable. I really do. I think that will help them a lot into next semester when they are doing their student teaching.

(Interview 12/17)

These science teachers were very supportive of the program and thought that the design of the course provided great advantages to traditional ways of passing through teacher education programs. One aspect that seems to support this is the belief that practical experience in the science classroom is much more important than anything that can be learned in the university classroom:

Ms. Flanders: And a lot of that stuff that we did (covered in pre-service education), I think you’ve just kind of got to do it. I can’t think of any class that I took at (the university) that really was all-inclusive in preparing me for what it would be like to teach. Even student teaching was totally different. I think the more they can get in here the better. (Interview 1/6)

Ms. Gumble: (It’s) necessary. I think they could use less time with (the professors) and more time in the classroom. From listening to the (pre-service) students, they realized that they gained more from being in the classroom than they did with them. And, they also question whether or not some of the techniques pushed by them, like inquiry, whether or not it was feasible in the classroom, whether you would achieve the goal that you set out to achieve. (Interview 12/18)
Despite the focus by the participants on the pre-service teachers, several benefits to their own practice were voiced as a result of mentoring within the course. The most common result among the science teachers was an increased degree of awareness about their own practice and a heightened degree of reflection about what they do in the classroom.

Ms. Quimby: I think any time you have someone in your classroom as much as they (pre-service teachers) were this semester, or with the example of the student teacher, you always have a second thought about is this really the best way to do this, or should I think tomorrow about redesigning this a little bit because it isn’t really what I need to be doing. So, there is always a reflective point for me, I think, as far as I probably need to be doing this a little bit differently. (Interview 12/17)

Mr. Hibbert: Having student teachers always helps me because it allows me to go over things that I take for granted and are tucked away in the back on my mind, which is always good. It refreshes your memory about what to do and what to say, and how to organize. If you have to go over procedures with someone else, it helps you remember the procedures yourself. (Interview 12/16)

The teachers who had worked with student teachers in the past did not seem to differentiate this experience from supervising more experienced pre-service teachers. Although each science teacher was involved in making a presentation to the entire pre-
service group about specific topics (planning, demonstrations, etc.), many felt that their involvement in this experience was minimal compared to working with student teachers who tend to assume more responsibility in the classroom:

Mr. Burns: It (mentoring in the course) hasn’t had any affect on the way I think about teaching. And, their involvement in the class was very limited anyway, so it’s not like it affected the way that the class was run or the way I teach. For the most part they were just in there observing and then did some mini-teaching for a couple of days. So it generally didn’t affect either (how he taught or thought about teaching) one of those. (Interview 12/16)

In contrast, some of the teachers expressed that their involvement with the course allowed them to try out new things in the classroom that they normally did not pursue. Most commonly, this centered on approaches to hands-on instruction that focused on the students:

Ms. Gumble: I did several labs that I had not done before. I also did some group activities that normally I would have just stood up in front of them and gone through the stuff. Something a little more interactive. (Interview 12/18)

Ms. Botz: I know that (the professors) are into a lot of inquiry labs, and I’ve tried to re-open my mind to exactly what is inquiry and what I can do to make sure that the kids are – I never wanted to be a cookbook kind of person, but I also know
that a little drop of freedom can go a long way with a lot of these kids…but I tried to reopen that door and see what little tweaks here and there that I can change to make it more inquiry. (Interview 12/12)

The reasons behind being more innovative in the classroom pointed both to the pre-service students in the classroom as well as the goals and expectations of the science education professors involved. Some of the pre-service teachers were more willing to become involved and attempt a variety of teaching styles, which likely had some effect on the amount of innovation by the science teachers.

By and large, all of the science teachers involved expressed that they felt more valued as a professional as a result of working with this program. When asked, most indicated that an underlying message behind science educators teaching the Methods and Curriculum course in the context of a secondary school was that their practice and wisdom was of importance. In a sense, it seems to recognize the expertise of the science teacher as being equal to the academic focus of the university. At the least, the teachers enjoyed being acknowledged as having something to offer:

Ms. Gumble: Oh yeah – at least they valued our expertise. Sometimes you feel like I’m just here, they (professors) really don’t want to find out what’s happening. Let’s face it – the rest of the (department) – they obviously don’t value the input of any teacher (since they are not involved in site-based courses). (Interview 12/18)
Ms. Flanders echoes this, but also points out the fact that she has actually enjoyed being a focus of research about teaching, as well:

Sometimes, it’s like who really cares about what we’re doing? The fact that you’re interested in asking these questions - no one has asked me this stuff before. I don’t know if caring is the right word, but no one has ever really had time or whatever. Yeah, I think so – that someone is finally looking at how we do stuff, or what we’re thinking or do we care? I do feel more valued. (Interview 1/6)

Other teachers expressed their appreciation for being included in the design and logistics of putting the course together, as opposed to having an outside agenda imposed upon them. From this, they felt that their input was important to making the course successful:

Ms. Quimby: I think so (feel more valued as a teacher) – from the meeting that we had last spring they (professors) were very interested in hearing what we had to say and how we could mesh what they needed and what we needed together. I think that they really did listen to us in terms of our opinions and views on things. (Interview 12/17)

There was no typical response across the six science teachers in terms of how this experience affected their beliefs about teaching or the way they practiced. Some were more open to trying out new methods or approaches, while others expressed a minimal impact on anything related to their classroom practice. The most prominent information
gained from this aspect of the research was in the effect this program had on the affective dimensions of the science teachers. All expressed positive feedback about their involvement with the program, especially in terms of feeling validated that science teacher educators feel that experienced science teachers have something of value to offer in the education of novice science teachers. Since the program seems to have little impact on the professional practice of these science teachers, there likely is minimal impact upon their models of being a science teacher. As illustrated in the discussion about the teacher models, the most common feature indicated involved having knowledge of students and their educational contexts. Working in this site-based course would not seem to have much impact in either of these two areas, especially in their knowledge of students. Some teachers indicated aspects of classroom teaching, such as gathering materials or new ideas, in their models. Working with these pre-service teachers may have exposed them to alternative methods of teaching in the classroom and increased their collection of science activities that they implement.

However, in relating the teachers’ models of being a teacher with their later reflections on the course, there seems to be no indication that in-service science teachers view science teacher education as a significant aspect of their job. None of the six teachers included terms or phrases like “mentoring” or “supervising student teachers” as a feature of their holistic view on being a teacher. With that in mind, they may minimize their own role as a mentor in a site-based course, despite their belief that experienced teachers have a great deal to offer in science education.
Discussion and Implications

Science Education Research

This study gives insight into a variety of areas relevant to science education research, especially in supporting the use of teacher-generated models as a method for gathering information about their professional beliefs and how they see their role as a science teacher. This is supported first by recalling previous research into the professional beliefs of teachers in science education. Additional discussion will show how this research supports Goodson’s (1992) rationale for research about the lives of teachers.

The earlier review of better understanding the professional of science teaching through the examination of teacher beliefs pointed to how such work shows the day to day issues facing teachers in real world situations. Like in those articles, the use of teacher-generated models helps show a great deal in terms of which aspects of being a teacher seem to dominate their thinking. It was clear from the models and words that certain components of being a teacher, such as interacting with students seemed more prominent than areas such as content knowledge.

More specifically, the research backs Goodson’s (1992) arguments for studying teachers’ lives in addressing larger issues of education. Of these, it most importantly supports the idea that acquiring knowledge about teachers’ lives provides insights into issues of school reform. Issues related to reform found in the teachers’ models include problems inherent in the support structures for many of their students and the substantial focus on non-teaching duties. Successful reform efforts likely need to address these areas that teachers consider problematic. Secondly, Goodson posits that studying teachers’
lives will provide information about the importance of experiences prior to pre-service education in shaping the identity of a teacher. This was illustrated in how Ms. Botz related her own role as a teacher to her past as a college student. There was an interesting parallel between how she wanted to help students achieve their own vision of the future with her experiences in becoming a science teacher. Finally, of Goodson’s three arguments for studying teachers’ lives provided earlier, this study gives little insight into better understanding issues of gender in teaching. At the least, the models and interviews of these science teachers support the idea that the ‘caring’ aspects of teaching are not limited to female teachers (Vogt, 2002) as the male teachers in the research stressed issues relating to meeting students’ non-academic needs.

Though the use of models as an attempt to understand the beliefs of teachers is not without problems, one major advantage is in maximizing the voice of the participant. The participants were able to reflect upon how they viewed teaching and being a teacher, expressing this with freedom and creativity. However, more tacit, but important, aspects of teaching may not manifest within the models. For example, the omission of content knowledge from several of the models seems at odds with the idea of experienced teachers having expertise in their subject matter. Subsequent interviews showed that the majority of these science teachers pointed out the importance of having a strong understanding of science in being a science teacher. Thus, the omission of such aspects of teaching may simply suggest that certain parts become more automated and less conscious, whereas the facets found in the models occupy a greater portion of the day-to-day thought processes of experienced science teachers.
For these science teachers, what seemed most important from the data collected through the models had little to do with their particular science course or the methods used to teach it. Several of the models altogether neglected any actual “teaching” in the model of teaching. Rather, at least within this particular school context the teachers were compelled to think more about the interpersonal issues regarding their students. This even spilled over into the second most cited category of Professional Knowledge as teachers frequently mentioned the need to be involved and supportive of their students in their extracurricular and community activities, as well. There was a sense felt from these participants that they could help their students not just with their academic struggles, but with their personal ones.

One particular aspect of this research raises a question that additional studies could inform. Specifically, understanding how the school context shapes the professional beliefs of a science teacher could provide information that would be useful for a variety of purposes, including the creation of professional development experiences for science teachers that are context-specific to their school environment. A comparison of models of teaching from science teachers in diverse settings could identify features common across settings as well as those more common to specific contexts. Previous research supports the ideas that context has an effect on teacher identity (Ben-Peretz et al., 2003), although teachers in that study were not provided an open-ended choice of expressing how they saw themselves as a teacher. Further research could address whether content-related factors were more prominent among teachers’ beliefs in high-achieving or high-SES settings. Lastly, longitudinal studies using teacher-generated models could provide information illustrating how school context shapes beliefs over time.
Site-based Secondary Science and Methods Course

Since this research was conducted within the context of a site-based Secondary Science Methods and Curriculum course, it is pertinent to examine the data in that light, as well. This design of teacher education places classroom teachers in a more prominent role compared to traditional courses, making it important to have a more detailed knowledge about these experienced teachers. The information provided by these models can better inform science teacher educators as they design pre-service experiences for their pre-service teachers. As an example, the high priority placed on student interactions and other non-teaching duties should compel teacher education programs to examine more ways to include experiences that would allow pre-service teachers greater opportunity to understand these aspects of teaching.

Though not a goal of the research, the models and interviews given by the participant science teachers lends support to using a site-based design for teaching core educational curriculum to pre-service teachers. Compared to a site-based course, traditional university-based courses minimize the amount of contact that pre-service teachers have with the adolescents they will eventually teach. Additionally, being in a school-based setting provides greater opportunity for understanding the political and structural influences working in the educational system. Spending greater time with practicing teachers enlightens the pre-service teachers about the degree of non-teaching responsibilities they will face when they are employed as a science teacher. This would seem to make them more fully aware of the nature of the profession.

Lines of research with pre-service teachers could further support whether the use of a site-based course was more appropriate in developing the many knowledge bases of
teaching as shown by Shulman (1987) and Barnett and Hodson (2001). Research that used pre-service teacher-generated models of teaching, similar to that outlined above with in-service teachers, could show how these novice educators viewed their role as a teacher as they progressed through their teacher education program. Additionally, comparisons of models developed by pre-service teachers in site-based courses could be compared with those in traditional science education courses in order to help examine the role of such varied course designs in shaping teacher beliefs. This last line of research could be extended longitudinally into the first few years of teaching, as well.

This research also informs science educators about using such a site-based design to help bring about changes with the mentor science teachers in the program. The research fails to substantiate the notion that a site-based course design had an effect on how the experienced science teachers viewed their professional role and beliefs. Their models omitted any mention of helping prepare future science teachers as a part of their professional beliefs. Though several mentioned minor changes in their classrooms as a result of their participation (i.e., trying a new activity), interviews pointed to the belief that partnering pre-service teachers with in-service teachers is much more beneficial to the former than the latter.

These teachers seemed to enjoy the experience of working in the program and appreciated feeling involved in its design and implementation. Since this partnership was new to the science teachers, perhaps it is not surprising that they do not view themselves as a significant part in developing new teachers. Involving these same teachers in future site-based courses may allow greater opportunity for them to develop a “science teacher educator” aspect as a part of their professional beliefs. If such a goal exists among the
designers of site-based courses, then developing specific methods of achieving those goals should follow. For example, the in-service teachers could receive professional development credit for completing their own assignments related to mentoring the pre-service students. These assignments might include the production of reflective journals and other projects that would heighten their awareness of their role in the course.

References


Cambridge: Cambridge University Press.
CHAPTER 3

BARRIERS TO TEACHING SCIENCE AS INQUIRY: A CASE
STUDY OF SIX SOUTHEASTERN U.S. SCIENCE TEACHERS

Introduction

The use of inquiry in science learning is embraced widely by science education, although its use in the classroom has not become widespread (Yerrick, 2000). As part of a larger qualitative study, the professional beliefs and practices of six secondary, in-service science teachers were examined to better understand the barriers that exist in implementing higher-level inquiry in their classes. During the course of the study, these teachers participated in a site-based Methods and Curriculum course that partnered them with one or two pre-service secondary science teachers over a 15-week period. Observations of the in-service teachers indicated a lack of emphasis on inquiry opportunities for science students. Interviews with these teachers illustrated that specific beliefs about (1) students; (2) state-mandated testing; and (3) issues of time are each problematic in supporting the teaching of science through inquiry. The implications of these findings in the context of the site-based Methods and Curriculum course are discussed.

Relevant Literature

The literature reviewed here will briefly highlight two relevant frameworks for this study. The first provides a history and rationale for the use of inquiry in science classrooms. Additionally, different types of inquiry are described to characterize this type of teaching and the attributes associated with it. The use of this approach in science
classes has been positively associated with a number of student outcomes, although the lack of inquiry in typical science classrooms still persists.

A review of teacher beliefs follows the discussion of inquiry. Research into teacher beliefs has been fruitful in establishing a relationship between what a teacher thinks and what a teacher does. Undertaking case studies while investigating teacher beliefs has provided better understandings of why teachers engage in particular behaviors and practices. The combination of these two research areas provides a rationale for examining inquiry through the beliefs of teachers.

Science as Inquiry

Recent policy statements by stakeholders in science education have pointed to the value of having students of science engage in inquiry throughout their education (AAAS, 1990; NRC, 2000; NSTA, 1995). Despite the recent dates of these publications, the push to bring this type of education into the typical classroom has roots earlier in the 20th century with John Dewey, perhaps the first to discuss the idea of inquiry in education (Hassard, 1992). In *How we Think* (1933), Dewey espouses what today’s science educators would recognize as a key component and rationale of the inquiry approach:

…the origin of thinking is some perplexity, confusion, or doubt. Thinking is not a case of spontaneous combustion; it does not occur just on ‘general principles.’ There is something that occasions and evokes it. General appeals to a child (or to a grown-up) to think, irrespective of the existence in his own experience of some difficulty that troubles him and disturbs his equilibrium, are as futile as advice to lift himself by his bootstraps. (p. 15)
Thus, Dewey takes the position that learning only happens in situations that provoke the student to think. Educators should design environments that take advantage of what is viewed as a natural process of learning.

Joseph J. Schwab built another piece of the inquiry foundation with the publication of *The Teaching of Science as Enquiry* (1962). Much of Schwab’s push for a more authentic kind of science education undoubtedly was fueled by the political climate of the late 1950’s and early 1960’s. Specific to the discipline of science, Schwab argued that learning through inquiry would benefit a democratic society by producing citizens who better understood the processes of science and the advances of technology. Additionally, with the rate of change in science growing at an ever-faster rate, simply understanding the “rhetoric of conclusions” in science was insufficient. A quality science education was one that provided a way to link the mind and the hand (Schwab, 1962).

Despite 40 years of momentum, science educators are still making similar pleas at reform. For example, Windschitl (2002) seems to echo the earlier wisdom of Dewey:

> For a science student, developing one’s own question and the means to resolve the question suggests an inquiry experience that is profoundly different from the far more common tasks of science schooling which consist of answering questions prescribed in the curriculum using methods also preordained in the curriculum or by the classroom teacher. (p. 114)
An explanation for the recent impetus behind a push toward greater inquiry in the science classroom may be linked to the wide acceptance of constructivist learning theory. Both science education research and standards support the idea that inquiry and constructivist approaches create meaningful learning environments (NRC, 1996; Tobin & Tippins, 1993).

Though an inquiry approach to teaching creates a classroom that is more student-centered, there is a danger in thinking that any student-centered science is inquiry. Crawford (2000) makes the distinction that “hands-on” science may often be unconnected to substantive science content and emphasizes the relationship between the designs of inquiry activities with how children learn science. Different degrees of inquiry have emerged from various publications to help sort out the levels of complexity inherent in this type of teaching. Drawing on these previous works (Germann, Haskins, & Auls, 1996; Herron, 1971; Schwab, 1962; Tafoya, Sunal, & Knecht, 1980), Windschitl (2002) describes a “continua” of inquiry in terms of the amount of independence that students have in answering their own questions. The continua begin with confirmation experiences where students verify by following directions, followed by structured inquiry, which places slightly more responsibility on the student by providing a question to which the students do not know the answer. These first two share the characteristic of having the teacher provide the methods for solving the given problem. In the last two types of inquiry, the methods for problem solving are left to the student. Guided inquiry provides a problem to the student, but leaves the solution up to the learner. The most independent in the continua is open or independent inquiry where students develop both their own problems and solutions. These latter two categories of inquiry seem to be what
Dewey and Schwab had in mind. With students free to make their own choices in solving problems, these are much more intellectually challenging for students (Windschitl, 2002).

The research base about inquiry has been both promising and disappointing. On the one hand there is a considerable amount of support for the positive influences inquiry can have on various aspects of science education. Inquiry-based science has been positively associated with academic achievement (Ertepinar & Geban, 1996), concept development (Palincsar, Anderson, & David, 1993), reasoning skills (Saunders & Shepardson, 1987; Wollman & Lawson, 1978), process skills (Padilla, Okey, & Gerrand, 1984), conceptual change (Fellows, 1994) and attitudes toward science (Selim & Shrigley, 1983). Despite these encouraging connections, the reality is that this type of learning environment is still not a common characteristic of science classrooms (Yerrick, 2000). Possible connections to this include the difficulty beginning teachers have in teaching inquiry (Adams & Krockover, 1997), limited instructional freedom (Songer, Lee, & Kam, 2002), role identity (Eick & Reed, 2002), and beliefs about teaching and learning science (Tobin, Tippins, & Gallard, 1994).

In summary, a long history of calls for the use of inquiry in science education has yet to lead to substantial practice with teachers of science. Neither the words of educational philosophers nor influential policy reform documents have brought about change. Though science learning may be more student-centered than it once was as teachers use “hands-on” approaches, the freedom for students to choose one’s own methods for answering questions about the natural world seems quite limited (U.S. Department of Education, 1999). Studies of various classrooms, using an assortment of
methods, have demonstrated positive student outcomes in the rare cases where inquiry is the main focus. Possible explanations have emerged for this inconsistency between the embrace of inquiry in research and the lack of implementation by teachers. As research has increased, a growing method for examining inquiry in science is through understanding of the professional lives and beliefs of teachers (Eick & Reed, 2002; Keys & Bryan, 2001).

**Teacher Beliefs & Actions**

Research over the past two decades has moved toward the pragmatic bridging of theory and practice as work began to inquire about the thinking processes of teachers (Clark & Peterson, 1986; Shulman, 1987). In the course of trying to figure out why teachers do the things that they do, the research area of “teacher thinking” developed. A general goal of researchers in this area has been to better understand the thought processes of teachers through looking at: (1) teacher planning and action; (2) thoughts during instruction; and (3) beliefs (Carlgren, Handal, & Vaage, 1994). Within this trio of research foci, the latter area of investigating the beliefs of teachers and their influence on what happens in a classroom has become quite prominent (Richardson, 1996). The construct of belief has been associated with a variety of other terms in the literature, including values, attitudes, judgments, opinions, perspectives, and explicit theories (Pajares, 1992). Although a number of related terms have been used in this area of research, Nespor (1987) provided a description of beliefs that has guided research. Though not necessarily a definition, Nespor’s construct of beliefs include being deeply personal, value laden, beyond the control of an individual, and resistant to persuasion. Richardson (1996) is more specific in defining that beliefs are psychologically held
understandings, premises, or propositions about the world that are felt to be true. Individuals may rely on their beliefs more than their knowledge to influence action (Nespor, 1987), fueling questions about the role of teacher beliefs in classrooms.

It is this link between belief and action that has been of importance to educators. Bryan and Atwater (2002), in reviewing research on teacher beliefs, describe beliefs as a part of the structure and content of a person’s thinking that presume to drive actions. Not surprising, the most general conclusion drawn from this research is that a teacher’s beliefs have strong sway over how he or she teaches (Brickhouse, 1990; Clark & Peterson, 1986; Nespor, 1987). More specifically, beliefs about student attributes, how students learn, and the nature of knowledge have been among the factors that influence teacher choices and actions (Brickhouse, 1990; Pajares, 1992; Zohar, Degani, & Vaaknin, 2001). For example, early research examining teachers’ beliefs found that teachers have varying levels of expectations for students, and their belief systems influence an array of ways for them to explain student actions and achievement (for a review of research focused on the relationship between teachers’ beliefs about students and academic achievement, see Clark & Peterson, 1986). Teachers of low-achieving students, in turn, may believe that higher order thinking is not appropriate for their pupils (Zohar, Degani, & Vaaknin, 2001). Additionally, teachers with a realist or factual conception of knowledge have been linked with practicing a traditional lecture style presentation of subject matter (Benson, 1989), whereas others have documented changes in teaching and assessment with teachers who have grown toward a more constructivist view of knowledge (Glasson & Lalik, 1993).
Further research investigated the influence of teacher beliefs on curriculum implementation among middle school teachers (Cronin-Jones, 1991). The two teachers in the study held beliefs about how students learn, beliefs about a teacher’s role in the classroom, beliefs regarding the ability levels of students at different ages, and beliefs about the importance of various subjects within the curriculum. These beliefs influenced certain actions in the classroom, such as emphasizing neatness and spelling, using drill and practice, and providing direction for their students.

Research on teacher beliefs among science educators has increasingly taken the form of such case studies. These often use both the words spoken by their participants and the observed practices from the classroom to discuss the relationship between belief and practice. Sarah’s beliefs about classroom management (Tobin & LaMaster, 1995), Karl’s beliefs about the student-centered classroom (Tobin, Tippins, & Hook 1994), and Barbara’s beliefs about elementary science teaching and learning (Bryan & Abell, 1999) are examples of research that used the construct of teacher beliefs to help make sense out of what occurred in each classroom. In the case of Sarah, for example, both beliefs and actions changed through the course of the study as she worked to see her social context in a different way (Tobin & LaMaster, 1995). Such case studies differ significantly from other works on teacher beliefs that relied heavily on questionnaires or forced-choice instruments (e.g., Beck, Czerniak, & Lumpe, 2000; Czerniak & Lumpe, 1996; Hasweh, 1996). The amount of time and detail inherent in this approach provides greater voice to the teachers in the studies, resulting in a rich and holistic account of the research environment (Merriam, 1998). This growing use of teacher beliefs in research and the
continued push for inquiry in the science classroom has intersected, creating a need for better understanding the role of teachers in implementing inquiry in their practice.

Teacher Beliefs and Inquiry

Keys and Bryan (2001), after synthesizing research on teacher beliefs and inquiry, developed a research agenda for the teaching and learning of inquiry. Recognizing the disconnection between reform documents promoting inquiry and the extant research base, they proposed using teacher beliefs as a central approach for closing the gap that exists between the theory behind the reform and the practical application in schools. More information is needed in the following areas: (a) teacher beliefs; (b) teachers’ knowledge base for implementing inquiry; (c) teacher practices; and (d) student learning from inquiry-based instruction. The lack of data that exist about the roles and knowledge of teachers as it relates to inquiry likely prohibits any meaningful reform (Keys & Bryan, 2001).

In developing their rationale for filling these holes in the research, Keys and Bryan (2001) provide ample evidence of research that has occurred relative to inquiry in science classrooms. Throughout these research synopses, one important theme becomes evident. There is a lack of teacher-developed inquiry activities in science classrooms, especially at the secondary level. Studies document meaningful student learning through inquiry. However, a limitation in these studies is that researchers typically have designed these experiences instead of teachers (Krajcik, Blumenfeld, Marx, Bass & Fredricks, 1998; White & Frederiksen, 1998). Also, the bulk of research on inquiry teacher practices seems to occur in the elementary setting (Keys & Bryan, 2001). What is known
about the beliefs and practices of secondary science teachers in the context of teaching
science through inquiry appears quite limited.

Context of the Study

In order to better understand the beliefs and practices of secondary science
teachers, a study was conducted within the context of a site-based Methods and
Curriculum course for pre-service science teachers. Recently, a segment of the secondary
science education program at a large southeastern university in the U.S. implemented a
new course structure for some of its students. The traditional “methods” block previously
consisted of 15 weeks of enrollment with 15 contact hours each week. The semester was
divided into thirds as students spent five weeks each on campus with professors at the
beginning and end of the semester, broken with a five-week practicum experience in
between at a local school. It was thought that this arrangement was not adequate for pre-
service teacher education, and plans began for providing a much more school based
experience with constant exposure to teachers, students, and the numerous other aspects
of school life (Oliver & Wallace, 2002).

Working with teachers at a local rural high school, this Methods and Curriculum
block of courses was moved out of the university. Students and professors met at the
high school three days each week, with the pre-service teachers spending one and a half
hours in the science teacher’s classroom and in a professor’s classroom for an equal
amount of time. Within the teacher’s classroom, pre-service teachers were able to learn,
observe, teach, grade, tutor and assist with a variety of tasks. The methods course became
more contextualized as the students were able to think about their observations from the
classroom during their sessions with the professors. The movement into an authentic
setting was viewed as a success and was repeated the following academic year at another local city high school.

During the 2002-3 academic year, this methods and curriculum block was hosted by Springfield High School, which served as the backdrop for this study. There are approximately 1200 students in this growing school. Though the district served by the school is largely rural, it is located about 10 miles from a swelling suburban community. The largest racial/ethnic group in the school is White students, composing about 60% of the population. African-American students make up about 37% of the school, followed by very small numbers of Asian and Hispanic students. Many of the students come from impoverished homes with about 40% eligible for free or reduced price lunches. State test scores are slightly below the state average in all categories. The faculty at Springfield is typical of many schools in the state, with over half holding advanced degrees, averaging more than 13 years of teaching experience.

**Research Methods & Framework**

The previous site-based Methods and Curriculum courses used data from their pre-service teachers to assess the usefulness of such an alternative approach in the teacher education program. To further provide information to make this site-based experience valuable for those enrolled, a research agenda was set to better understand the beliefs and actions of the participating in-service teachers. Within the context of this site-based methods course, a broad study was conducted to answer the following research question: What are secondary science teachers’ beliefs about science teaching and learning? Additional research questions included: (a) How do these teachers describe and define through models their beliefs regarding science teaching and learning? (b) How are their
beliefs expressed in their professional practice? and (c) How does the teachers' participation as mentors in a field-based methods course influence their thinking about science teaching and learning?

In order to answer the research questions, the case study approach, guided by an interpretive qualitative methodology was used (Merriam, 1998). Theoretical frameworks of both cognitive constructivism and sociocultural perspectives directed both the design and collection of data. Constructivism can be thought of as a theory of knowing where an individual’s knowledge is built through experiences in the world (von Glasersfeld, 1989). A knowledge base is valued by its usefulness more than its ‘truthfulness’. Because of this, the idea that different teachers would have different representations of teaching steered the research. The participant in-service teachers had different backgrounds in education and teaching. These experiences shape the way that they view their profession and their role as a teacher. Additionally, a sociocultural perspective takes into account other influences on teaching and learning (Gergen, 1995). The structures imposed by the school setting and the discipline of science likely share in some influence on the beliefs and actions of those in the school (Eisenhart, Finkel, & Marion, 1996). This research sought to use these frameworks to interpret the various actions and beliefs about teaching held by the participants.

A feature of many case studies is the use of interviews and observation (Merriam, 1998), and these are the main sources of data for the study. In this study, the objects of the case were six in-service science teachers at Springfield High School. These six teachers (four female, two male) were chosen for their role in hosting the pre-service secondary science teachers in their classrooms. All six participants had taught at the
school for at least four years, with several having taught there for more than fifteen. (see Table 2.3 for teacher characteristics). Each teacher participated in open-ended, semi-structured interviews throughout the semester that elicited their professional beliefs on a variety of topics related to teaching (Appendix B). Additionally, each was observed eight to ten times for over an hour in duration on each visit. Field notes were taken using a laptop computer during these classroom visits, documenting such things as teacher actions, student actions, questions, and classroom activities. An interview at the close of the semester partially served to allow the participants to comment on their observed instructional and discipline practices.

Purpose and Development of Study

As a part of the larger research design explained previously, this article examines the collected data to answer the following question: What professional beliefs of secondary science teachers create barriers to the use of inquiry in their classrooms? This question allowed the researcher to address the broader research questions mentioned previously, specifically those regarding the professional beliefs of secondary science teachers and how those beliefs relate to their classroom practice. During the frequent classroom observations of in-service teachers, it became apparent that higher-level student inquiry was absent from virtually all of the classrooms. By and large, the teachers were very organized, knowledgeable about the content that was presented, and cultivated classrooms that were quite student-centered. Despite the considerable amount of time in which students were actively doing something in the classroom besides listening to the teacher or watching a video, five principle types of activity occurred (from Field Notes): (1) Completing handouts, worksheets, or book work where students
often worked together in small groups, but these were usually used to reinforce or introduce concepts in the particular curriculum; (2) Building models where students would work in groups to build a model of an abstract concept. Examples of this included using toothpicks to construct a longitudinal wave and designs of communities that were environmentally friendly; (3) A variety of games, such as bingo or jeopardy were used to reinforce concepts, especially vocabulary, from the science content; (4) During confirmation labs students followed a set of directions to arrive at a conclusion that was already discussed in class, such as investigating particular chemical properties; and (5) In low-level inquiry, activities provided both the question(s) for investigation and the methods to answer them (Windschitl, 2002). Physical science classes, for example, generated conclusions about forces from investigations such as measuring the results of balls rolled from a ramp. These activities served a variety of purposes, most notably to present information and assess student knowledge or understanding. In general, students were quite involved in these activities and seemed to enjoy being able to work in these student-centered environments. With rare exceptions, though, no ‘higher-level’ inquiry was observed. This observation was at odds with some objectives for the pre-service teachers visiting their classrooms.

Since the context of this study was a site-based Methods and Curriculum class, it is important to realize the goals and rationale for that course. In describing the development of this site-based course, Oliver and Wallace (2002) indicate that the idea of conducting science methods courses in a high school setting has its roots in the theoretical framework of “cognitive apprenticeship”, a way of situating learning tasks in an authentic setting (Collins, Brown, & Newman, 1989). One of the key components of
cognitive apprenticeship is observation, which helps the novice construct a conceptual model of the target performance (Collins et al., 1989). Thus, students better learn to become a teacher by observing a teacher do his/her job.

A problem is encountered, however, when reform-based teacher education goals fail to match the practice of partner teachers in such a situation. One of the main topics as outlined in the syllabus for the pre-service teachers is inquiry-based science. Echoing the goals of reform documents (AAAS, 1990; NRC, 2000; NSTA, 1995) the pre-service teachers are encouraged to use inquiry science in their classrooms during the times they are able to teach. In particular, one of the assignments for the course was to design and conduct an inquiry-based lab for the students in the partner classroom. Pre-service teachers in this setting may better grasp issues of time management, curriculum demands, and student characteristics. But little or no modeling of higher-level inquiry by those they observed make the cognitive apprenticeship model less useful for this particular aspect of the Methods and Curriculum course.

Why was little or no inquiry occurring these science classrooms? Though not the specific intent of the broad research outline to answer this specific question, the data gathered from this study provide insight to the variety of reasons, barriers, or constraints that may prevent teachers from allowing students to pursue their own scientific questions and/or choose their own methods to answer such questions. It is important to note that questions such as, “Why is inquiry-based science absent from your classroom?” were not asked to these participants. Rather, the interview excerpts used come from conversations regarding a variety of issues related to teaching, such as student characteristics, planning, classroom management, assessment, etc. This is not considered a limitation of the
research, however. The expressed beliefs of the participants from these other queries illustrate the lack of congruence between the way they view the many aspects of their profession and the characteristics of inquiry-based science.

Data Analysis

Because of the research framework, the coding of these interviews was influenced by concepts and ideas developed prior to engaging in the interview process or looking at the data. Miles and Huberman (1994) support this idea of starting with a set of theoretical or conceptual-based codes prior to beginning the research, and these guided the choice of interview questions. All interviews were audio taped and transcribed. In reading the transcripts additional themes (as generated by the participant) became conceptualized during the analysis. In coding the data, the approach mentioned by Strauss and Corbin (1990) was adopted: “…the analyst also might code by analyzing a whole sentence or paragraph (original emphasis). While coding a sentence or paragraph, he or she might ask, ‘What is the major idea brought out in this sentence or paragraph?’ Then, after giving it a name, the analyst can do a more detailed analysis of that concept” (p.120). Thus, beginning with this idea, the first of three steps was begun in coding.

During open coding (Strauss & Corbin, 1990) all transcripts were read with sentences and paragraphs given various labels based on ideas, beliefs, or aspects of teaching represented. Some similar codes were combined together. Various code names came either from the preconceived interview topics or from the words of the participants. Axial coding (Strauss & Corbin, 1990), examining connections among codes, followed. In practice, open and axial coding was somewhat simultaneous. From this, a chart was developed for each participant that illustrated transcript excerpts for each code. After
deciding upon the focus of this particular article, selective coding (Strauss & Corbin, 1990) discriminated among codes that were relevant to the research question. From these codes emerged the categories that will be discussed at length below. These categories indicate how beliefs about students (immature, need routine, lack motivation), beliefs about time (too large of a science curriculum, other responsibilities), and beliefs about testing (on content and assessment) influence the type of science experienced by Springfield students. An example of the coding procedure is given in Appendix D.

Participants

Six of the eight full time science teachers at the school participated in the study. Of the two omitted, one did not host a pre-service teacher and the other was absent from school on medical leave during a portion of the semester. Each participant was observed in one specific class during all observations, although some teachers had more than one course preparation. Classes were approximately 90-minutes in length.

Ms. Gumble. Ms. Gumble had over 30 years of teaching experience at several different schools. She had a strong background in Chemistry and is the only participant who teaches it, although she occasionally taught a freshman Physical Science course. Her Chemistry course was likely similar to others across the state in that her intention is to prepare her students for college. Her classroom attached to a chemistry lab room of which she had sole use, and she designed lab experiences frequently for her students. The class period observed with Ms. Gumble was composed of about 20-23 eleventh grade students, most of whom were White (from Field Notes).

Ms. Quimby. Holding a graduate degree in education and an undergraduate degree in biology, Ms. Quimby was in her 21st year of education. She expressed a love
for environmental issues and taught both Ecology and Human Anatomy and Physiology. The students in these two courses were quite different. Students in the Anatomy course were largely college-bound, while those in Ecology (the course observed for this study) were usually taking it for their last general science credit. Additionally, the Ecology course was inclusionary with students who were receiving special education services. Students engaged in a variety of projects, supplemented by interactive lectures and handouts. A co-teacher certified in special education assisted with this class of 15-20 students, almost equally divided in numbers between African-American and White students (from Field Notes).

**Ms. Flanders.** Ms. Flanders came to teach science from a background in horticulture. She received her teaching certification several years after completing her undergraduate program. In her eleventh year of teaching, the fifth at Springfield, she generally taught Physical Science to freshmen. Following a typical routine, class began with an assignment as students enter the room. After discussing this, they usually completed a pattern of covering content through use of handouts or discussion, followed by some type of hands-on activity, ending with a wrap up or review back at their desks. Ms. Flanders had begun this year teaching a section of Physical Science for students enrolled in the gifted program, which was observed for this study. The class had about 20-22 students, all of which were White except for one African-American girl (from Field Notes).

**Mr. Hibbert.** In his 18th year of teaching with a degree in Zoology and graduate degree in Science Education, Mr. Hibbert almost always had taught Biology and A.P. Biology students. His easy going and calm demeanor seemed to resonate well with his
kids. Like the other teachers, he had a very good knowledge of the science content and presented concepts in a variety of ways to his students. They took notes, watched videos, played games, and engaged in labs. Most of the 25 or so students in the Biology course were in tenth grade, with about equal numbers of White and African American students (from Field Notes).

**Mr. Burns.** The newest member of the science faculty, Mr. Burns was in his fifth year of teaching with broad field science certification, all at this school. Although he had taught Biology, his classes were usually Physical Science students. This particular year the school implemented a program for students scoring poorly on eighth grade standardized tests. Instead of completing their science course over one semester, they took it over the entire year. Thus, Mr. Burns taught three Physical Science classes for “low-achieving” students. New to having these students, he was often frustrated by the mismatch between his own preferred style of classroom interaction and the behaviors of his students. Mr. Burns genuinely cared about his students despite the often-uncooperative behaviors they exhibit. The class observed had approximately 20 students each day, about three-quarters of which were African-American (from Field Notes).

**Ms. Botz.** She has ten years of experience with seven at this school. Her background was in Chemistry, but primarily teaches Physical Science to ninth graders and those who are repeating the course. Although she brought a good deal of content knowledge from her pre-pharmacy background, many of the students also knew her for her extracurricular work as the cheerleading coach. Her class was composed of the “middle-of-the-road” students, and her teaching routine was quite similar to Ms. Flanders. There were approximately 20-23 students in the class observed, with the racial
composition fairly reflective of the overall school at two White students for every one African-American (from Field Notes).

Results

The data from these teachers’ interviews were analyzed to provide examples of beliefs that would likely inhibit the use of open or guided inquiry in their classrooms. Using the characteristics of inquiry that have been described in the literature, a variety of beliefs regarding science teaching at this particular school emerged, with three broad categories most prominent: beliefs about students; beliefs about time; and beliefs about testing.

Beliefs about students

Throughout the interviews, teachers often referenced their students in response to a myriad of prompts, such as managing a laboratory activity, planning their lessons, or student motivation, often pointing to perceived shortcomings in their students. These student references provided a starting point for illustrating barriers to using inquiry in their science classes since one of the key characteristics of open or guided inquiry is the degree of increasing student self-direction and student-centered work (NRC, 2000). At the most self-directed end of the inquiry spectrum, students should be able to: (1) pose their own questions; (2) determine what constitutes evidence and collect it on their own; (3) come up with explanations after summarizing their evidence; (4) examine other resources independently and make links to other explanations; and (5) form reasonable arguments in order to communicate their explanations (NRC, 2000). It would seem that teacher beliefs at odds with the independence needed to meet these goals would create a barrier to science teachers implementing this type of a learning environment.
Students are too irresponsible. These teachers pointed to a general level of irresponsibility among many of their students. One of the issues was the lack of trust built by the students with their teachers:

Ms. Flanders: So, I don’t trust them with much. With ninth grade I don’t do a long lab. They’re more like demonstrations; they aren’t true experiments, that’s for sure. They don’t use fire because I don’t trust them. They burn stuff. They burn each other. (Interview 9/5)

Ms. Botz: Technology is expensive, so you have to be able to trust students, and not all students do I trust. (Interview 9/4)

Mr. Burns: I would love to use them (computers) and there is no way that I would ever bring that into my classroom, which is very unfortunate. These kids break and can’t even handle the most basic and indestructible lab equipment that we have. We have kids that like to steal and like to break, and do not have respect for equipment. They would dump a drink over on a laptop and immediately try to hide it instead of stepping forward and admitting it…I wish that I had students I felt were responsible enough to use a $2000 laptop. (Interview 9/9)

Neither of these three Physical Science teachers was specifically asked about the amount of trust they had in their students, yet each pointed out their beliefs that their students were not to be trusted with safely handling materials in their classroom. This lack of trust
seemed to influence both the types of materials and instructional decisions that are made for their students.

The issue of being able to appropriately use materials was echoed in a couple of specific examples:

**Ms. Botz:** And then, the biggest thing is limiting their access, for example, we did physical and chemical changes, and they had to tear up a piece of coffee filter, put it in a watch glass, and burn it. So, I don’t say in the materials list ‘a box of matches’. When it gets to that point I say, ‘Go get a match from the teacher’, so I know that your group is about ready to go burn, so I will walk over there….When I say a match, that’s what they get – a match. Don’t ever give a box of matches because you might (only) get one back. They’re going to sit there and they’re going to light them, because they’re fascinated by fire. I don’t know why, but they are. (Interview 9/4)

**Mr. Hibbert:** You have to be there watching because students are going to find ways to make mistakes that you have never thought of, and you need to try to head that off at the pass. Even an A.P. lab. You know, I'll put the electronic scales out, and we're weighing dialysis bags. And if I hadn't been there constantly looking over their shoulders I wouldn't have seen that half of the scales were set to ounces and half were set to grams. Students are constantly having questions. They read and they just don't quite get it. And they say 'what's the point of this?'
or 'how do I do this again?' And your being there and managing it are very
important. (Interview 8/27)

From specific experiences, these teachers indicate that students may have problems
responsibly handling possibly dangerous materials or correctly using laboratory
equipment. As a result, they significantly curtail the amount of freedom their students
have.

Students are immature. Somewhat related to the beliefs about lack of
responsibility was the immaturity of students in the science classes. The use of inquiry in
the classroom calls for students to assume a great deal of responsibility in their learning.
Believing that students lacked maturity would likely inhibit giving them much choice in
their educational pursuits. This belief had connections with how these teachers viewed
their students’ ability to attend to their own learning, to complete tasks, and to work
cooperatively with others.

Mr. Hibbert and Mr. Burns indicated that the younger students in high school
have problems understanding complicated ideas. An additional problem was the lack of
long attention spans:

Mr. Burns:…at least my students this year are not really mature enough to know
when to switch on their brains and when to switch them off… (Interview 8/29)
Mr. Hibbert: Ninth graders don’t have the abstract abilities to grasp all of these complex cycles and ideas that happen in biology, ecology, and evolution and so forth. They can’t grasp what they’re going to do next year. (Interview 8/27)

Going a step beyond the students’ perceived mental functioning as it relates to maturity, teachers additionally felt that their pupils’ immaturity made it difficult for them to complete assigned tasks, especially when working with others:

Ms. Gumble: I think the trends have been in education to be more student-focused than teacher-focused, and I try to do that whenever I can, although that doesn’t always work because they go nuts…They would rather goof around. (Interview 9/10)

Ms. Gumble: …they are so used to group work that they tend to get into a group and want to socialize. (Interview 9/10)

This inability for students to cognitively engage in and complete their work led to frustration and initiated feelings of hopelessness:

Mr. Burns: When you have a class of 18, and 15 of them are clowns, there’s not a whole lot you can do, unfortunately. (Interview 8/29)
In situations such as this, it would seem unlikely that open or guided inquiry would occur. The perceived lack of cognitive engagement of their students, combined with frustrations of getting them to work cooperatively in meaningful tasks worked to create a barrier to the use of self-directed inquiry. As teachers selected learning objectives and materials that limit the educational autonomy of their students, it was possible that they contributed to creating students that became more and more comfortable with structured learning environments. As Mr. Burns succinctly put it:

Mr. Burns: The younger and more immature the student, the more direction, guidance, and lack of flexibility I am going to give them. (Interview 8/29)

The National Science Education Standards (NRC, 2000) suggests that teachers begin by providing a great deal of structure for their students, followed by gradually allowing for more autonomy in inquiry as the year progresses. Though this is inevitably a much better path to undertake than simply allowing for open inquiry from day one, teachers who perceive a lack of maturity in their students may be unwilling to provide the opportunities for students to slowly move across the continuum to more self-directed inquiry.

Students need routine. Following from the discussion above is the belief that students both expect and perform better if their classroom experiences are somehow routine. The ability to develop one’s own questions or to choose one of several ways to solve a problem seems in conflict with providing set directions or structure for students. These teachers expressed beliefs, some based in described experiences, that indicated
both their thoughts on the importance of routine and the perception that students themselves prefer order, structure and regularity in their science experiences:

Ms. Gumble: …when I do a lab, I basically do the same things – the paper they pick up is in the same place, because kids do respond much better to a routine. (Interview 9/7)

Ms. Botz: That way there’s no surprises – they know what’s coming. I don’t see what is the big deal about ‘Oh, I wonder what we’re doing in science today?’ When they come into my room they should know what we’re going to get done. (Interview 9/2)

The beliefs of these two teachers seemed to indicate that they felt teaching was enhanced by providing routines for the students. As Ms. Gumble hinted, students actually needed routine and performed better when the expectations are known. Ms. Flanders seemed to echo these sentiments, indicating that a long history of schooling for her students creates certain expectations:

Ms. Flanders: I guess because when we are brought up as little kids we still are in that traditional little dictatorship, so that when kids are put in a situation where they don’t have that, they don’t know what to do. (Interview 9/5)
Like some of the examples related to responsibility and maturity, specific past experiences have helped either create or reinforce such a belief about students and their need for the familiar and routine. Attempts at implementing new instructional strategies for learning vocabulary in Ms. Flanders’ room was met with fairly widespread rejection:

Ms. Flanders: Today I came up with this idea – OK, we’ll do the vocab(ulary) and we’ll draw pictures, so in your head - you should have heard my one class. “I don’t get this. This is dumb. I don’t think in pictures. Can I just do it the other way?” …They wanted to write it out like they’ve always done. I think that they’re kind of always set, unfortunately. And trying to open them up isn’t always very easy. (Interview 9/5)

Breaking a pattern of at least eight years of educational history could be difficult, and several of these teachers viewed their students’ past as creating somewhat of a conditioning in them. Though students may frequently work in small groups on a variety of assignments, these were generally not as cognitively complex as those found in examples of open or guided inquiry. From their elementary and middle school experiences, students at Springfield rarely, if ever, were exposed to learning environments that challenged their problem-solving and conclusion-drawing abilities (from Informal Discussion). By the time they reached high school, it became much more efficient for the science teachers to continue teaching in ways that were comfortable for the students instead of going through the pains of trying something new.
Students are not motivated. The last area that likely creates a barrier for the use of guided or open inquiry at Springfield was the lack of student motivation perceived by the science teachers. Though advocates of inquiry would argue that allowing students to investigate problems that are of concern to them would increase their motivation (NRC, 2000), believing that students have little concern about school or science may prevent teachers from investing the time and resources to create opportunities for their students. If students were unwilling to complete typical assignments for class, teachers may wonder why they would suddenly become involved in more challenging, possibly more difficult ones. This could be especially true if teachers equated lack of student motivation with lack of student ability.

Some of the teachers perceived a lack of motivation due to the high number of students not passing their classes or from a comparison of their current students with those in the past:

**Mr. Burns:** It would be really nice if all of my kids were motivated by grades like they would be in a private school. When I went to school you just did what you needed to do, and I think that I have 1 or 2 students, if I’m lucky, in each class that are actually trying a little bit to pass. (Interview 9/9)

**Ms. Gumble:** They’re getting less and less motivated… Used to, you could - grades would motivate them, or eligibility would motivate them, or wanting to get into a good college would motivate them. (Interview 9/10)
Ms. Botz took the emphasis away from grades or extracurricular eligibility and focused more on the student’s desire to actually learn:

Ms. Botz: But just general, run of the mill kids are not going to come to you dying to learn. They are going to dread coming in because a lot of people hate science – the subject of science overwhelms them and confuses them. (Interview 9/2)

Her beliefs indicated that even if students wished to do well enough to pass a class, they still may have little desire to engage in learning, especially when the subject was science. In terms of finding attributes for this low motivation, Mr. Hibbert explained a common perception among most of the teachers pointing to the high rate of poverty among their students and the many characteristics thought to be associated with it:

Mr. Hibbert: …motivation is a huge problem here because you get a lot of students from low-income backgrounds and broken homes and families who are not really here for them at all. They don’t see very much reason to be motivated by anything. School is just the farthest thing from their minds. They don’t see how it’s going to affect the future in positive ways. It’s really difficult for us at this stage of their lives to communicate how school is going to help them. It’s a big problem. (Interview 8/27)

Realizing the substantial number of students who seemed to have more important concerns than school, teachers at Springfield interpreted this as a lack of motivation among those in
their classrooms. Whether the students actually were motivated is almost beside the point. As we look at this from a cognitive constructivist perspective (von Glasersfeld, 1989), these teachers’ reality was that their students are driven very little either to do well in school or to learn science.

In combining these beliefs about students, these teachers have built a fairly strong wall that would seem to prevent them from wanting to provide self-directed inquiry opportunities for their students. Believing that students were not responsible, were immature, had little motivation, and responded best to the routine and familiar, introducing new situations where students worked freely on their own problems would seem unlikely to encounter any degree of success. Unfortunately, other barriers to teaching science as inquiry may have held more sway over teachers than their beliefs about students.

Beliefs about time

Teachers mentioned time-related issues in many discussions during interviews. Time seemed to be influential in many of the decisions that the participants made during the course of the day, week, and semester. Most felt that whatever the context, they never had enough of it, often feeling rushed to get tasks completed. Schedule changes and other circumstances further eroded the amount of free time many of these teachers had during the semester. Increased enrollment necessitated shorter lunch periods, and an unfilled part-time teaching position resulted in covering additional responsibilities over the first six weeks of the semester.

Although teaching science as inquiry does not always require more time-consuming methods, engaging students in authentic science experiences does. One example of open inquiry in a Biology classroom mentions that students spend several
weeks collecting and analyzing data in order to learn more about the natural environment (NRC, 2000). Students visit a field site and work on a variety of related topics back at the school. These types of experiences may often be precluded by the limitations of time-related issues among typical science teachers.

The curriculum is too large. Students enrolled in a particular course for a set amount of time. In the case of Springfield High School, teachers had their students for 90 days over the course of a semester for about 90 minutes each day. In reality, this number became substantially smaller, as exam days, inclement weather, and scheduled school activities and assemblies cut into this number. Within this time frame teachers had a state-mandated science curriculum that had to be completed. The breadth of this curriculum varied by topic, but teachers often felt constrained by time to adequately cover all of the material with their students. One of the largest content areas was Biology, a core requirement for all students:

Ms. Quimby: I won’t even say what I think about the biology state curriculum because I think it’s just crazy that there are so many objectives and so little time to teach it. (Interview 9/4)

Mr. Hibbert: Biology is very frustrating because it is a huge curriculum. It’s gigantic and there's no way, especially on the block schedule that you can squeeze everything in. It's just impossible….So, it's extremely difficult. (Interview 8/27)
The teachers felt very little freedom to stray from the state standards, despite the feelings that many of the objectives are of little value for their students. An additional outcome of this broad curriculum was that students get a very superficial understanding of many different concepts, but were unlikely to have any deep learning about any of the topics:

**Mr. Hibbert:** A lot of what they do in biology they will never ever need to know, many of the students will never have to worry about it again. It’s kind of a pain. I think the curriculum is way too packed, crammed with useless things for most of the students. (Interview 8/27)

**Ms. Flanders:** It’s dumb. So, you’re an expert at nothing and you know a little bit about everything? I don’t know. I don’t think that’s a good idea. (Interview 9/5)

Despite teachers having to cover a great number of topics during the course, often it was impossible to complete them all. In addition to limiting the amount of detail that was covered for a particular topic, these time constraints may even force teachers to make choices to omit particular parts of the curriculum:

**Ms. Botz:** So, you know about how long you have to take for the physics, then what you have to do for the chemistry. So, at the beginning of the year we decide which chapters we’re throwing out and which chapters we’re keeping. (Interview 9/4)
These curricular restraints often affect the choices and decisions teachers made with their students. None of the teachers singled out the curriculum itself as being problematic, only that having to cover the curriculum in the allotted amount of time was troublesome. These teachers were experienced enough to understand that they only have a certain number of days to cover a particular topic. Mr. Hibbert, for example, knew that he might have nine or ten days to cover his unit on ecology. This timeframe may equate to three or four chapters of information in the book, leaving very little time for active inquiry by his students. Returning to the idea of motivation, these teachers usually provided time for their students to work on assignments that could otherwise occur at home. This occurred mainly because most have found from experience that the majority of their students fail to thoroughly complete homework assignments (various interviews). Review of content and preparation for tests often took the time that could be used for open inquiry.

Other responsibilities. Teachers were not only limited by time in covering state-mandated curricula with their students, but were also limited in the amount of time they were able to allot to the teacher-student aspect of teaching. Secondary science teaching included additional duties, such as working at or supervising co-curricular activities, participating in various school committees, scheduling and attending student support meetings, and monitoring hallways, bathrooms, parking lots, and the cafeteria. These activities often ate away at time before or after school. Planning times were also made less efficient by slow classroom computers and downed networks, waiting in line to use one of the two copiers (at a school with over 80 faculty, administrators, and support staff), or completing an increasing amount of bureaucratic paperwork.
With the amount of teaching experience among the participants, many had witnessed the growth in their non-teaching responsibilities and how it took away from the time they were able to devote to instruction:

**Ms. Quimby:** It amazes me every year at just how much more paper work they pile on. I just, there are more and more and more things that we have to do outside the classroom. You know, as far as, not only things that have to be written up, but even duties. (Interview 9/5)

**Mr. Hibbert:** Bureaucracy and administration don't have any concept...if you constantly add every month a new duty onto a teacher that something else has to be taken away because you have a limit. If I added up a list of all of the new duties and responsibilities, new things to memorize, new things to do and learn since 1985, I wouldn't have any time to breathe. They don't have that concept, you know? Let's get the teachers to do it - one more thing won't hurt. Then it's one more thing the next week and the next week. (Interview 8/27)

**Mr. Burns:** …supporting the kids in whatever they’re doing, whether it’s the debate team or whatever….So that’s a big part. It takes up tons of weekends and afternoons and stuff, so that’s a big part of a teacher’s life. (Interview 8/29)

One of the effects of this lack of time was that the teachers’ time for planning gets cut. These non-teaching hours were when they grade assignments, prepared labs or
activities, and designed assessments. As this time gets eroded, the process of planning for instruction was compromised:

Ms. Gumble: I would have things a little bit more prepared (if I could)…and I think I would be much more effective. But you have to deal with time constraints and all of that. That would be the major thing. I think I could plan better if I had more time. (Interview 9/7)

Ms. Flanders: There’s no time. If we could have one day a week. OK, one day every three weeks, one day a month, where no one would bug us, where we could do this long-term, and probably some short-term planning, I think that we would all be better teachers, but there is not enough time. There’s just, to grade everything, to make copies, or take care of kids or other stuff. You have committees. That probably the most frustrating thing…there’s never enough time. (Interview 9/2)

With this plethora of obligations, combined with trying to cover a great deal of science content in a relatively short amount of time, teachers tended to value efficiency, mentioning practices such as allowing groups of students to turn in papers in order to cut down on the amount of grading. These time and curriculum constraints provided neither the freedom in their classrooms nor the leisure in planning that would support the implementation of open inquiry learning situations. With their many years of experience, these teachers often had notebooks or file cabinets full of activities, worksheets, and
demonstrations that related to teaching their particular science. When time ran short, it was much easier to rely on these tried and true methods of teaching. Time constraints can work as a major concern for teachers when reform-based methods are considered (Anderson, 1996). Examples of open inquiry in secondary science as illustrated by the NRC (2000) are likely unpractical in high schools faced with similar constraints.

**Beliefs about testing**

In situations where science teachers are confined by their curricular obligations, it may be that the solution to the problem is to work to streamline the curriculum, which is precisely what the NRC (2000) advocates:

…the "mile wide and an inch deep" curriculum often decried in U.S. education…

There are several steps that teachers and administrators can take to deal with this problem. They can renegotiate the expectations embodied in the curriculum. They can carefully select a few areas to emphasize, spending more time teaching those areas though inquiry. They can carefully analyze the curriculum expectations and combine several learning outcomes in lessons and units. They can work with other grade-level teachers to eliminate the redundancies that often exist in a curriculum, but rarely deepen understanding. If they teach subjects other than science, they can integrate science outcomes into other subject areas (for example, presenting the findings of an investigation in a language arts lesson). Teachers and administrators can be helped by district and state decision makers who can reduce the number of topics that teachers are required to teach. (pp.135-6)
Though few might argue that these are not appropriate ways of handling a very broad curriculum, this position fails to take into account obstacles in the real world of science teaching. One of the main issues here is the struggle between state and local control of education. At Springfield High School, students are held accountable for their education through high-stakes testing. The centralized state Department of Education ultimately has the final say in terms of both the science curriculum and the statewide exams. Over the last half-decade, for example, students have been required to take a science exam (along with other content areas) that focuses on scientific processes, biological sciences, and physical sciences. These areas are taken straight from the state curriculum. Thus, teachers who want their students to have exposure to the topics on the test need to stay within the guidelines of the state curriculum. The NRC suggestions are not quite applicable in such situations, especially at schools such as Springfield where test scores are below the state average.

**Content.** Many of the teachers at Springfield taught before the advent of such testing programs. Because of these tests, the choices made in class content among the participants has changed:

**Mr. Hibbert:** And before the graduation tests I really did worry about it (teaching topics relevant to students). I said, ‘Look, these kids, I want to try to teach them what's fun; try to teach what maybe they can use in their life, and I'm going to try to teach them things that they're more interested in.’ And all the boring things that I think the typical person doesn't need to know I just left them out. And the stuff that I taught we did very well on, and really the end of the course exams and the
graduation tests have forced me to be a little more comprehensive even though I think if something is useless I'll try to throw it in and drill it into their head a few times, which is really bad because you’re just wading in an inch of information instead of giving deep into things. (Interview 8/27)

Teachers have to spend time on topics they feel are irrelevant to the student in hopes that they will do well on the graduation test. Those who care about their students cannot simply gloss over assessed curriculum areas simply because they believe certain areas are irrelevant. These test scores go beyond simply making the schools either appear effective or failing through reports in media outlets. Students who did not pass these tests did not receive a diploma. These teachers felt an obligation to their students:

Ms. Botz: …you don’t really have a choice because you know you want the best for these kids, and these kids are going to have to take that test ,and you want to make sure that you have covered that material. (Interview 9/4)

The power of these tests to alter what happened in the classroom is evident from the words of Ms. Quimby. She was the teacher whose students were enrolled in the course least affected by the graduation test (Ecology). Some of her students were twelfth graders who had already taken it. Others were eleventh graders who were scheduled to take it during the spring, but the Ecology class was technically not assessed as a part of the science test.
These students already completed their Biology class, leaving Ms. Quimby with little need to consider the science graduation exam in choosing topics for her class:

Ms. Quimby: I enjoy teaching that class. I enjoy the topic. But, I enjoy teaching that class because it gives me the freedom to do a lot of different things and the projects that we do. I’m not tied to having an end-of-course or graduation test.

(Interview 9/5)

These state tests were powerful agents of curriculum influence in schools such as this where three out of every ten students failed to pass the science portion of the graduation exam on their first attempt. Teachers who otherwise may opt for more intensive study of particular topics felt obligated instead to gloss over all of the topics in a way they feel will better serve their students in succeeding on a fact-based multiple choice test that determined their graduation status. Simply choosing to omit topics or eliminate redundancies (because students may have not learned the topic in previous grades) was not a viable option. This additional barrier of needing to prepare students for tests reinforced the curriculum time barrier.

Assessment. In additional to affecting the choices of content in the science classroom, standardized testing has an impact on the assessments used by the participants, as well. The state tests rely solely on multiple-choice items to assess student knowledge. Thus, these science teachers have followed suit by designing their assessments to match those that will eventually hold their students accountable:
Ms. Flanders: I feel like our society puts so much on objective testing I guess that’s one of the reasons, that’s why it’s such a main focus. (Interview 9/2)

Ms. Botz: If I didn’t have to rely on the graduation test, knowing that they’re going to have to take it. I would really look at a kid who is failing every single test, and see if there was a different way that I could assess them. But I don’t do that because I know they are going to have to take that test. (Interview 9/2)

In addition to designing assessment to match high-stakes exams, these teachers also noted the influence of these tests on the choice of more alternate assessments:

Ms. Botz: They have projects and all of this, but I have to stop because I know that the kids are going to be tested with the graduation (exam). To get their final credit they’re not going to be tested that (projects) way. So, I really feel like it’s a waste of time to assess them that way unless I thought that it would be beneficial to them, and I don’t. (Interview 9/2)

Ms. Quimby: Because of end of course exams, graduation tests, and all of those things, we focus a lot more on that (assessment) now on anything else, but in Ecology…I vary my assessment a lot. (Interview 9/5)

Ms. Botz pointed out that she had moved away from project-based learning that she used in the past because her students would be held accountable through other types of
instruments. In contrast, Ms. Quimby mentioned the ability to use varied assessment in her Ecology class, although other classes had more of a focus on traditional assessments because of state testing. Since it was difficult to assess understanding, inquiry ability, or inquiry understanding through multiple choice (NRC, 2000), the fact that students were evaluated on the state level by multiple choice tests seemed to indicate that these tests do not assess a student’s inquiry capabilities. Thus, what motive was there for teachers to encourage these skills in their students when high-stakes testing will not assess such skills?

About Epistemology

A number of previous studies have addressed the relationship between a science teacher’s epistemological beliefs about science and the type of teaching/learning that occurs in his or her class. For example, case studies of science teachers have indicated the possibility that teachers understandings about the nature of science (Lederman, 1999) or the structure of their subject matter (Gess-Newsome & Lederman, 1995) differ somewhat from the type of instruction in those teachers’ classrooms. In some cases, teachers were found to have deep, sophisticated understandings about science and its structure, although these types of goals were not necessarily emphasized in their classrooms. Other inconsistencies between epistemological belief and classroom action lead to questions about the power of competing beliefs, such as the desire for keeping an orderly classroom (Yerrick, Pedersen, & Arnason, 1998) and the belief that school science somehow differs from authentic scientific inquiry (Munby, Cuningham, & Lock, 2000).
On the other hand, researchers have reported consistencies between constructivist practice by science teachers and their epistemological understandings of knowledge. Brickhouse (1990) highlighted two teachers who had classroom practices that mirrored their own belief systems about science. Lawson, in her study, understood the importance of theories in science and communicated an understanding of the utility of scientific theories to his students. Echoing research about the consistencies of belief and practice is the case study of Martha, whose shift from a positivist to social constructivist epistemology was followed by changes in how she allowed her students to approach learning and problem solving (Glasson & Lalik, 1993).

The data taken from the interviews and observations of the teachers at Springfield High School pointed to a number of constraints working against the implementation of higher-level inquiry in their classes. This additional question of epistemology should not be ignored, since the possibility exists that if all of the remaining barriers were removed, these teachers would continue constructing their classes in the familiarity of the status quo. Portions of the interview data support this additional possibility that these teachers possibly understand science in a way that is more aligned with the culture of school science (Glasson & Lalik, 2000) than with scientific epistemologies that support higher-level inquiry.

Though none of these teachers were specifically asked questions that related to their understanding of the nature of science or other epistemological-related prompts, small portions of the data show how these teachers largely indicate the “factual” nature of the science taught in their classes. In talking about instruction, Ms. Gumble mentioned, “And I could throw out a concept to them and they would grasp it” (Interview 9/7). This
idea of getting the students to understand the content was also found in Ms. Botz speaking about chemical concepts:

**Ms. Botz:** So you have to kind of cast that to the side and realize that what it boils down to is that this kid has to know this QCC. Your job, or the job of the teacher, is to put it out there in as many different ways that they can physically and mentally think of, through labs, through whatever, in hopes that sometime, the eighth time, that they’re trying to find the atomic number of lithium, that they’ll remember we did it with paper. We did it with coloring, and that eventually something will click. (Interview 9/4)

Though these science teachers want their classes to be student-centered and engage in a number of teaching strategies, the underlying goal is for the students to learn the information found in the textbooks or in the state curriculum. Although inquiry is a goal of both texts and standards, there is often more of a focus on content-related aspects. Mr. Burns supports this as well:

**Mr. Burns:** I think most teachers, myself included, are kind of, at least in science, are QCC (state curriculum) objective-driven. We’ve got a million and one objectives and they’re all layed (sic) out and you have ‘X’ amount of time and you’ve got to get them all in. They’re very specific. The textbook that we use does a decent job of following that. So, I’d say that a lot of the way I teach is
curriculum driven. Not necessarily the way I teach, but what I teach and why I’m teaching it. I cover stuff that needs to be covered. (Interview 9/9)

These data raise the possibility of an additional barrier to the implementation of higher-level inquiry in these science classes. If these science teachers held a positivist orientation to understanding science, perhaps the removal of other barriers would not facilitate a change in instructional practices. With the vast experience of most of the teachers in the study, this would likely be a formidable barrier to overcome.

Discussion

The purpose of this article was to address the question: what beliefs of secondary science teachers create barriers to the use of inquiry in their classrooms? The conversations and time spent with these participants over the course of the semester indicated clear barriers to student-directed science inquiry. Among the most prevalent beliefs of these teachers were that their students exhibit characteristics at odds with independent learning. The additional constraints of time and state-mandated testing were also problematic in implementing inquiry in their classes.

Learning science through inquiry places a great deal of responsibility, both in thought and in behavior, on students to work through science problems. These experienced teachers held a number of beliefs about many of their students that are at odds with allowing for increased freedoms. These beliefs led to inferences that might prevent science as inquiry. Teachers who believed that students are immature and irresponsible would seem unlikely to increase the degree of learning autonomy for their students. Issues of safety and the destruction of materials led teachers to restrict access to
materials and cooperative group work. Compounding this lack of trust was the belief that students were not motivated, making it unlikely for them to complete assignments. In order to deal with these first two beliefs, teachers felt that students needed structure in their learning. Teachers indicated that students likely would not perform well in situations where problems and methods were unknown, a key aspect of open-ended inquiry.

Even if teachers did not hold such beliefs about their students, additional reasons made the use of inquiry in science classroom problematic. Many factors beyond their control contributed to how classroom time is structured. The teachers’ beliefs about the need to cover the science curriculum in a way that benefits students on high-stakes testing omitted the deeper connections that can be made through inquiry. There is an evident frustration among these educators that testing influenced how they choose to cover content and assess their students. Even if the curriculum were condensed to allow more freedom in pedagogy, the additional job responsibilities of a teacher prevented them from searching for and developing inquiry learning activities during non-school hours and their planning times. Many of the content and assessment decisions made for their classes are influenced by state-mandated testing issues, which further reinforced the constraints of the curriculum.

In tying these three belief areas together, a picture emerged that illustrated the typical teacher in this school setting, one that was likely to be found in many schools throughout the country where similar socioeconomic factors and high-stakes testing were present. These teachers were knowledgeable about their science content and wanted their students to succeed in their coursework. Their students needed a great deal of guidance
to push through a science class in which they were likely disinterested. The process of juggling numerous job responsibilities while trying to cover a large science curriculum in a short span of time resulted in valuing efficiency. In turn, the result was teaching methods that made the best use of class time and planning time. Worksheets and short activities allowed teachers to cover a great number of topics in a short amount of time. Additionally, most of these were ready-made and either come along with their curriculum materials or were activities collected over years of experience. The drawback that this type of teaching may not result in deep understanding of science was offset by the knowledge that state assessments tended to focus on factual science knowledge. Thus, these teaching choices were believed to be the most appropriate in regards to testing.

Objections or counterarguments can likely be made against many or all of these teacher beliefs. In reality, the students may have been mature and responsible enough to handle more self-directed learning. They could have become motivated by greater challenges and thrive in a less routine setting. These teachers might have been able to cover their curriculum in ways that adequately prepared students for tests and included inquiry, too. However, these are difficult beliefs systems to overcome, especially given the large amount of experience within this cultural context of the six participants. Beliefs are not easily changed (Nespor, 1987), and returning to the cognitive constructivist perspective (von Glasersfeld, 1989) emphasizes that these strong belief systems act as a reality for the teachers.

**Implications for Science Education**

Teaching science through inquiry has long been a goal in science education. Supported by recent policy statements (AAAS, 1990; NRC, 2000; NSTA, 1995), it is
largely absent from most science classrooms (Yerrick, 2000). As Keys and Bryan (2001) have pointed out, a great deal of what lies behind this reform is research focusing more on how students learn rather than in how teachers teach. The examination of teachers’ beliefs allows a better understanding of the mental processes that drive their actions and choices in instruction. Despite the growing support indicating how learning through inquiry in science is beneficial (NRC, 2000), the results of this study echo recent calls for taking into account the beliefs and practices of teachers who are to enact this type of learning environment (Keys & Bryan, 2001).

Though not directly attempting to assess teachers’ understanding or lack of implementation of inquiry, it was clear that a number of variables may promote or impede its use. Teacher-initiated inquiry activities in schools with characteristics as those found at Springfield would lend credibility to the “do-ability” of inquiry. Though examples exist from other settings, vignettes from moderate and high-poverty schools forced to deal with issues of high-stakes testing would better indicate what could reasonably be expected in these settings. Previous case studies note the need for research in “typical” schools when reform issues are involved (Anderson, 1996).

One problem of generating such successful vignettes lies in the absence of open inquiry in these science classes. A more active collaboration among pre-service teachers, in-service teachers, and the professors of site-based courses could provide cases of open inquiry that were successful in such a typical setting. Attempting this would scaffold in-service teachers as they tried unfamiliar methods while illustrating practical use of inquiry to pre-service teachers. Such activities would need to take into account the belief barriers described above. This may prove to be a difficult task when university faculty
and teachers in a secondary school work together for the first time. As a site-based
course recurs at the same school, these collaborations may be more successful as all
parties involved better understand the needs of one another and relationships are
strengthened between the school and the university.

A second issue is that educators need to work together at both the school and
university level to push for state-level changes when curricular or testing
implementations are at odds with research-based teaching and learning. The NRC (2000)
supports this position, “Teachers and administrators can be helped by district and state
decisionmakers who can reduce the number of topics that teachers are required to teach”
(p. 136). However, this does not seem to recognize the lack of power that individual
teachers and administrators have in changing state-level policy and curricula. Concerted
efforts among all stakeholders in the educational system need to effectively lobby for
such changes. Additionally, national organizations pushing for reform have a
responsibility to work at state levels and with state organizations to produce curriculum
guidelines that support teaching science as inquiry in typical secondary classrooms.

Finally, professors and instructors of site-based Methods and Curriculum courses
need to take into consideration the beliefs and practices of in-service teachers at the
schools where they work, although this may be difficult when university faculty partner
with in-service teachers for the first time. Placing pre-service teachers with educators
who share different values and goals from the teacher education program may be
counterproductive in certain ways. With this particular issue of learning to teach science
as inquiry, pre-service teachers found little support for this in the classroom they
observed. This may subtly send the message that students do not need exposure to
inquiry science in order to understand the content. Pre-service teachers may value the practice of in-service teachers over the goals of the teacher education program.

In situations where inquiry is not modeled in the typical classroom, it may be effective for pre-service teachers to reflect through journals and discussions about such issues (Kagan, 1992). Expressing their thoughts on issues like low student motivation would help make explicit the beliefs they hold that may prevent them from using inquiry once they are in the classroom. Creating assignments where pre-service teachers interview their partner teacher about specific pedagogical issues (e.g., classroom management, assessment, testing) may allow them to better understand the practices and choices of their experienced host. Confronting tensions that exist between the goals of a reform-minded Methods and Curriculum course and the practices of typical classroom may lead new teachers away from the status quo and into more progressive practices.

For reform thrusts such as having students learn science as inquiry to gain momentum in science classrooms throughout the country, it is likely that each of the ideas expressed above needs to be addressed. Current teachers feel constraints from many different directions that influence their practices. It is likely difficult for their practices to change without meaningful, contextualized professional development opportunities that model successful inquiry situations in classrooms such as theirs. A site-based Methods and Curriculum course could address these professional development needs as it simultaneously prepares pre-service teachers for their careers. These opportunities need to be coupled with more flexible state curricula and testing procedures that provide greater freedom for teachers to engage their students. On the other hand, new teachers entering into schools will likely fall into the same habits as those already
teaching unless they are adequately prepared for the difficulties in implementing reform-based science teaching. The cognitive apprenticeship model seems an effective way to expose pre-service teachers to the authentic context of school, although it may inadvertently socialize them to develop beliefs at odds with reform as they work in classrooms that lack opportunities for student inquiry. With proper consideration, however, practitioners of site-based courses can address these constraints and assist their pre-service students in implementing specific types of inquiry.

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CHAPTER 4
CLASSROOM MANAGEMENT ISSUES IN GRADE 9 PHYSICAL SCIENCE: A CASE STUDY OF THREE SCIENCE TEACHERS

Introduction

Issues of classroom management and order are concerns of teaching that are especially problematic for novice and pre-service teachers. This qualitative study uses a framework of teacher beliefs (see Clark & Peterson, 1986) to make explicit the practices and decisions of three experienced Physical Science teachers as they worked to keep order with their students. During this study, the three were also involved as mentors to pre-service teachers enrolled in a Secondary Science Methods and Curriculum course. This pre-service course was guided by a cognitive apprenticeship model of teacher education (Collins, Brown, & Newman, 1989), allowing novice pre-service teachers greater opportunity to understand issues of teaching, such as management practices, in science classes.

A review of issues of classroom management and cognitive apprenticeship provide a research base for the study. Data were collecting using methods typical of case studies (Merriam, 1998), specifically interviews and participant observations. From the words and actions of these three teachers, four specific areas are indicated as pertinent to their work of attempting to maintain order in the classroom. These four areas (teacher’s personality, the teacher’s perceived role, the physical classroom environment, and students) combine to create a unique situation of management for each teacher. The
implications of these findings for a site-based course and on broader issues of science education research are discussed.

Relevant Literature

Classroom Management

Of all the tasks to be mastered as an educator, there are possibly none more worrisome than that of classroom management. Studies have supported that beginning teachers are most concerned about dealing with student behavior and management of the classroom (e.g., Tamir, 1991). Pre-service Methods and Curriculum texts, as well as smaller stand-alone works, offer teachers a variety of suggestions, theory, advice, and vignettes about how to deal with students in their classrooms (e.g., Campbell, 1999; Freiberg, 1999a; Hassard, 1992; Porter, 2000; Shimahara, 1998a). Despite the concern and the ample reading materials on the subject, classroom management is one of the most complex and difficult areas of education (Lasley, 1994).

Whether mastery of this complex aspect of teaching is a pre-requisite or co-requisite for classroom learning is a matter of debate. However, the assumption that classroom management is necessary for effective teaching is a common idea across many cultures (Shimahara, 1998b). The complexity of classroom management is evident in the difficulty of giving the phrase a succinct definition. Doyle (1986) summarizes the construct:

Classroom management refers to the actions and strategies teachers use to solve problems of order in classrooms. Because order is a property of a social system, the language of management must be addressed to group dimensions of the
classroom environment and to the contexts to which order is defined and achieved. Management is a complex enterprise because order is jointly accomplished by teachers and students and because a large number of immediate circumstances affect the nature of orderliness, the need for intervention, and the consequences of particular teacher and student actions. (p. 397)

For Doyle, order means that “students are following the program of action necessary for a particular classroom event to be realized in the situation (p. 396).” Kounin (1970) found that this development of order in a classroom was more a function of good managers designing their classrooms to prevent disruptions than it was or redirecting disruptive student behavior. Thus, the idea of being an effective classroom manager goes beyond simply dealing appropriately with student behaviors at-odds with the goals of the teacher. Teaching behaviors and student interaction are possibly of greater importance in maintaining a well-managed environment.

Much of what is known about classroom management comes from studies similar to what led Kounin (1970) to those conclusions. Simply stated, research has identified variables that are associated with teachers who are described as effective classroom managers. Doyle (1986) provides a comprehensive review of a wide range of factors that have been reported to have an impact on classroom management. Among these, summaries show that student behavior seems to be affected by the types of activities in which they are involved (e.g., Burns, 1984), the congruence between student skill level and assignment difficulty (e.g., Metz, 1978), a teacher’s behavior in the early portion of the school year (e.g., Evertson & Emmer, 1982), and the type of interventions teachers
use in addressing behaviors (e.g., Erickson & Mohatt, 1982). Much of this research occurred when classroom management was typically behaviorist in nature (Frieberg, 1999b), although many of the findings associated with quality management supported non-behaviorist ideas.

More recent perspectives about classroom management have shifted away from issues of control toward that of caring (Weinstein, 1998). This dilemma of caring versus controlling students has been found in beginning teachers (McLaughlin, 1991) who shy away from a desire to intimidate or control their classrooms. Additional developments, such as an increasingly diverse student population in United States’ classrooms, has continued the need to re-assess classroom management practices. Weinstein (1998) provides examples from research showing how the strategies used by European-American middle-class teachers may not be useful with students of color (Ballenger, 1992; Delpit, 1988). Interactions with these students may produce different results from what teachers intend.

Classroom research has produced a number of findings that support management approaches that are more effective than others. As more becomes known about issues of motivation and student interactions, teacher educators can more easily relate these findings on to their pre-service teachers. Despite this increase in knowledge, there still seems to remain little understanding of how pre-service teachers can become better managers of classrooms. A great deal of research on classroom management focuses on in-service teachers, especially at the elementary level (see Doyle, 1986). Providing better ways for pre-service teachers to come to grasp with issues of management would likely make their transition into the classroom more productive.
Situated Learning and Cognitive Apprenticeship

Developments in how we think about learning have influenced changes in the structures of learning environments. In particular, the nature of many learning tasks are not well suited to traditional school settings (Resnick, 1987). Collins et al. (1989) elaborated, “Even today, many complex and important skills, such as those required for language use and social interaction, are learned informally through apprenticeship-like methods – that is, methods not involving didactic teaching, but observation, coaching, and successive approximation” (p. 453). Additionally, many of the educational practices in schools place little weight on higher thinking skills that prompt students to integrate knowledge (Collins et al., 1989). This lack of integration and reliance on didactic teaching may impede novices from becoming experts and strong problem-solvers. Aspects of becoming an expert teacher, such as managing a classroom, require skills that are largely learned while engaged in the practice of teaching (Brown, Collins, & Duguid, 1989). Thus, learning to teach in the social setting of a classroom in an apprenticeship-type context would seem to provide advantages to novice teachers.

An instructional model that is gaining prominence to provide such a context is based in situated learning theory (Clancey, 1992). Also referred to as situated cognition, this theory suggests that learning is tied to authentic activities, contexts and cultures, and that learning occurs by completing tasks in authentic situations (Brown et al., 1989). Situated learning theory draws on earlier ideas developed by Vygotsky (1978), who supported the idea that learning occurs by cooperating and interacting with others in a social environment. Advantages to participating in such situations include increased motivational support, exposure to the expert thinking of others, and increased
possibilities for debate (Resnick, 1989). Drawing on these ideas, the concept of cognitive apprenticeship was developed (Collins et al., 1989). Since a great deal of what must be known in teaching is learned in the classroom (Lave, 1996), this model seems well suited for teacher education.

The cognitive apprenticeship model of teaching and learning has several features. Specifically, these include the social setting, content, sequence, and methods (Collins et al., 1989). The **social setting** should be designed so that learning becomes situated to reproduce real-world situations relevant to the learning task. This social setting can involve either authentic contexts (Brown et al., 1989) or problem-solving environments (Collins, 1991). In the discipline of teaching, for example, novice teachers should learn in an authentic classroom since this will be the context of their future work. In addition to factual knowledge, the **content** features would include heuristic, control, and learning strategies (Collins et al., 1989). Students would pick up skills in problem-solving, metacognition, and understanding about learning to support their knowledge traditionally associated with content. The **sequence** of cognitive apprenticeship develops learning tasks so that students are familiar with the holistic context of the learning environment prior to moving into specific tasks. Additionally, tasks begin on the simple end of the spectrum and move to increased difficulty (Collins et al., 1989). Finally, the **methods** of cognitive apprenticeship are varied. Students observe experts engaged in the task they are to learn and engage in dialogue explaining the processes they see. As the student begins to engage in tasks, the expert is able to “coach” and give feedback. Additionally, students are prompted to make their knowledge and understandings more explicit, often
by having opportunities to reflect on their practice. Finally, students are able to invent and/or try out new strategies in their authentic context (Collins et al., 1989).

The use of cognitive apprenticeship and situated learning has been reported in a wide range of disciplines. In pre-college settings, examples can be found where this framework has guided instruction in both science (Roth & Bowen, 1995) and foreign language instruction (Hosenfeld, Cavour, & Bonk, 1996). Multimedia and instructional technology have used cognitive apprenticeship and situated learning to both promote higher-order thinking and to scaffold programming (Chee, 1995; Herrington & Oliver, 1999). With adults, the cognitive apprenticeship model has been used for clinical experiences in nursing (Taylor & Care, 1999) and the development of leadership profiles in school administration (Begley, 1995).

Despite its use in learning in such diverse areas, cognitive apprenticeship seems yet to have gained wide use within teacher education, despite suggestions from pre-service teachers that additional time within an authentic setting (i.e., the classroom) would better prepare them (Adams & Krockover, 1997). However, several examples in the research literature describe the use and effectiveness of extended field-based experiences, situated learning, and cognitive apprenticeship within pre-service teacher education (Eick, Ware, & Williams, 2003; Mosenthal, 1996; Munby, 1999; Roth & Boyd, 1999). As opposed to traditional student teaching, these approaches more often refer to the situation between the pre-service and in-service teacher as co-teaching. Pre-service teachers may work together with the in-service teacher to assist with the lesson simultaneously (Roth & Bowen, 1999), or they may observe a lesson during one period and teach the same lesson in the subsequent period with needed assistance from the in-
service teacher (Eick et al., 2003). These studies suggest an increased comfort level in the classroom for pre-service teachers as they transition to greater independence in the classroom.

Methods

Research Question

With issues of classroom management being paramount for new teachers, the implementation of a cognitive apprenticeship model within a Methods and Curriculum class would ideally strengthen the ability of pre-service teachers to handle issues of management. In a cognitive apprenticeship model, pre-service students would spend a great deal of time in the classroom observing their co-teacher. However, a great number of variables might shape the experiences and observations that particular pre-service teachers have in the classroom. This research seeks to answer the following question:

What beliefs related to experiential factors contribute to the characteristics of classroom management of 9th grade Physical Science teachers?

Description of Study

This research is a portion of a larger study conducted within the context of a site-based Methods and Curriculum course guided by a cognitive apprenticeship model. To further provide information to make this site-based experience valuable for those enrolled, a research agenda was set to better understand the beliefs and actions of the participating in-service teachers. Within the context of this site-based methods course, a broad study was conducted to answer the following research question: What are secondary science teachers’ beliefs about science teaching and learning? Additional research questions included: (a) How do these teachers describe and define through
models their beliefs regarding science teaching and learning? (b) How are their beliefs expressed in their professional practice? and (c) How does the teachers' participation as mentors in a field-based methods course influence their thinking about science teaching and learning? This article particularly deals with the questions about secondary science teachers’ beliefs about science teaching and learning and how their beliefs are expressed in their professional practice.

Framework of Teacher Beliefs

The central focus on beliefs in this study was used to help better understand the practices of participant teachers. Bryan and Atwater (2002) describe beliefs as a part of the structure and content of a person’s thinking that presume to drive actions. Individuals may rely on their beliefs more than their knowledge to influence action (Nespor, 1987). The construct of belief has been associated with a variety of other terms in the literature, including values, attitudes, judgments, opinions, perspectives, and explicit theories (Pajares, 1992). Nespor (1987) described the construct of beliefs to include being deeply personal, value laden, beyond the control of an individual, and resistant to persuasion. Richardson (1996) is more specific in defining that beliefs are psychologically held understandings, premises, or propositions about the world that are felt to be true. Through combining the methods of interview and observation, it was hoped that practices of teaching, such as classroom management, would be explained through the beliefs shared by participant teachers. Since these participants represent the target goal in the cognitive apprenticeship model, understanding the reasoning behind their actions should facilitate the progress of novice pre-service teachers toward independence.
Context of the Study

Recently, a segment of the secondary science education program at a large southeastern university in the U.S. implemented a new structure for its pre-service students. The traditional “methods” block previously consisted of 15 weeks of enrollment with 15 contact hours each week. The semester was divided into thirds as students spent five weeks each on campus with professors at the beginning and end of the semester, broken with a five-week practicum experience in between at a local school. It was thought that this arrangement was not adequate for pre-service teacher education, and plans began for providing a much more school based experience with constant exposure to teachers, students, and the numerous other aspects of life (Oliver & Wallace, 2002).

Working with teachers at a local rural high school, this Methods and Curriculum block of courses was moved out of the university. Adopting a cognitive apprenticeship framework, the course was designed so that students and professors met at the high school three days each week, with the pre-service teachers spending one and a half hours in the science teacher’s classroom and in a professor’s classroom for an equal amount of time. Within the teacher’s classroom, pre-service teachers were able to learn, observe, teach, grade, tutor and assist with a variety of tasks, adhering to many of the tenets of cognitive apprenticeship (Collins et al., 1989). The methods course became more contextualized as the students were able to think about their observations from the classroom during their sessions with the professors. The movement into an authentic setting was viewed as a success and was repeated the following academic year at another local city high school.
During the 2002-3 academic year, this methods and curriculum block was sited in its third iteration, Springfield High School, which served as the backdrop for this study. There are approximately 1200 students in this growing school. Though the district served by the school is largely rural, it is located about ten miles from a swelling suburban community. The largest racial/ethnic group in the school is White students, composing about 60% of the population (Georgia Department of Education, n.d.). African-American students make up about 37% of the school, followed by very small numbers of Asian and Hispanic students. Many of the students come from impoverished homes with about 40% eligible for free or reduced price lunches. State test scores are slightly below the state average in all categories. The faculty at Springfield is typical of many schools in the state, with over half holding advanced degrees, averaging more than 13 years of teaching experience.

Data Collection

In order to answer the research question, the case study approach, guided by an interpretive qualitative methodology was used (Merriam, 1998). Theoretical frameworks of both cognitive constructivism and sociocultural perspectives directed both the design and collection of data. Constructivism can be thought of as a theory of knowing where an individual’s knowledge is built through experiences in the world (von Glasersfeld, 1989). A knowledge base is valued by its “usefulness” more than its “truthfulness”. Because of this, the idea that different teachers would have different representations of teaching steered the research. The participant in-service teachers had different backgrounds in education and teaching. These experiences shape the way that they view their profession and their role as a teacher. Additionally, a sociocultural perspective
takes into account other influences on teaching and learning (Gergen, 1995). The structures imposed by the school setting and the discipline of science likely share in some influence on the beliefs and actions of those in the school (Eisenhart, Finkel, & Marion, 1996). This research sought to use these frameworks to interpret the various actions and beliefs about teaching held by the participants.

A feature of many case studies is the use of interviews and participant observation (Merriam, 1998), and these are the main sources of data for the study. In this study, the objects of the case were six in-service science teachers at Springfield High School. These six teachers (four female, two male) were chosen for their role in hosting the pre-service secondary science teachers in their classrooms. All six participants had taught at the school for at least four years, with several having taught there for more than fifteen. (see Table 4.1 for teacher characteristics). Each teacher participated in open-ended, semi-structured interviews throughout the semester that elicited their professional beliefs on a variety of topics related to teaching (Appendix B). Additionally, each was observed eight to ten times for over an hour in duration on each visit. Field notes were taken using a laptop computer during these classroom visits. An interview at the close of the semester partially served to allow the participants to comment on their observed instructional and discipline practices.

Data Analysis

Because of the research framework, the coding of these interviews was influenced by concepts and ideas developed prior to engaging in the interview process or looking at the data. Miles and Huberman (1994) support this idea of starting with a set of theoretical or conceptual-based codes prior to beginning the research, and these guided
Table 4.1
Profiles of Participant Science Teachers at Springfield

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Education</th>
<th>Years of Teaching</th>
<th>Class Observed</th>
<th>Student(s) in Course</th>
<th>Class Size</th>
<th>Other Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ms. Gumble</td>
<td><em>Chemistry</em> M.Ed. <em>Science Education</em></td>
<td>33</td>
<td>Chemistry</td>
<td>College-bound 11th Grader</td>
<td>20-24</td>
<td>None</td>
</tr>
<tr>
<td>Ms. Quimby</td>
<td><em>Biology</em> M.Ed. <em>Science Education</em></td>
<td>21</td>
<td>Ecology</td>
<td>Vocational-Track 11/12th Grader; Special Education</td>
<td>15-20</td>
<td>Human Anatomy &amp; Physiology</td>
</tr>
<tr>
<td>Ms. Flanders</td>
<td><em>Horticulture</em> Additional coursework in <em>Science Education</em></td>
<td>11</td>
<td>Gifted Physical Science</td>
<td>Top 9th Graders</td>
<td>20-24</td>
<td>Physical Science</td>
</tr>
<tr>
<td>Mr. Hibbert</td>
<td><em>Zoology</em> M.Ed. <em>Science Education</em></td>
<td>18</td>
<td>Biology</td>
<td>All variety 10th Graders</td>
<td>24-26</td>
<td>A.P. Biology</td>
</tr>
<tr>
<td>Mr. Burns</td>
<td><em>Science Education</em></td>
<td>5</td>
<td>Academy Physical Science</td>
<td>9th Graders with Past Academic Problems</td>
<td>15-20</td>
<td>None</td>
</tr>
<tr>
<td>Ms. Botz</td>
<td><em>Science Education</em></td>
<td>10</td>
<td>Physical Science</td>
<td>“Middle-of-the-Road” 9th Graders</td>
<td>18-24</td>
<td>None</td>
</tr>
</tbody>
</table>
the choice of interview questions. All interviews were audio taped and transcribed. In reading the transcripts additional themes (as generated by the participant) became conceptualized during the analysis. In coding the data, the approach mentioned by Strauss and Corbin (1990) was adopted: “the analyst also might code by analyzing a whole sentence or paragraph (original emphasis). While coding a sentence or paragraph, he or she might ask, ‘What is the major idea brought out in this sentence or paragraph?’ Then, after giving it a name, the analyst can do a more detailed analysis of that concept” (p.120). Thus, beginning with this idea, the first of three steps was begun in coding. During open coding (Strauss & Corbin, 1990) all transcripts were read with sentences and paragraphs given various labels based on ideas, beliefs, or aspects of teaching represented. Some similar codes were combined together. Various code names came either from the preconceived interview topics or from the words of the participants. Axial coding (Strauss & Corbin, 1990), examining connections among codes, followed. In practice, open and axial coding was somewhat simultaneous. From this, a chart was developed for each participant that illustrated transcript excerpts for each code. After deciding upon the focus of classroom management, selective coding (Strauss & Corbin, 1990) discriminated among codes that were relevant to the research question. From these codes emerged the themes presented in the results. An example of the coding procedure is presented in Appendix D.

Participants

Of the six participants, three will be presented here due the varied types of student behavior found in each class. Each of these three teachers was observed working with Physical Science classes, although on very different levels. Springfield High recently
made a change in some of the ways students are placed in these classes. In particular, a large group of students scoring below the 25th percentile on their 8th grade Iowa Test of Basic Skills (ITBS) were placed in a yearlong course, separate from the other students who take the class on a one-semester basis (a class period is 90 minutes). Additionally, two classes of 9th grade students described as “gifted” were scheduled together for a course. Because of these changes, three different academic ‘levels’ of students were created in the school. Each of the following teachers was observed in one of these three levels:

- Ms. Flanders, a teacher with eleven years experience, was in her 5th year at this school and was new to the experience of teaching gifted students. She had consistently taught Physical Science courses throughout her tenure and entered teaching after a short career in the sciences. Her gifted class was composed of all 9th grade students. She is in her early 40’s.

- Ms. Botz, in her early 30’s, had ten years of experience with seven at this school. She had a background in Chemistry, but primarily taught Physical Science to 9th graders and those who are repeating the course. Many of the students knew her for her extracurricular work as the cheerleading coach. Her class was composed of the “middle-of-the-road” students.

- Mr. Burns, in his mid 20s, was the youngest faculty member in the science department, and this was his fifth year of teaching science after graduating college. He had taken on the task of teaching the 9th grade students scoring
poorly on the ITBS. All three of his classes were composed of these students, who are described as “at-risk”.

The data presented here were derived from various classroom observations of the teachers in their class and the interviews that occurred during the semester.

**Data Story**

**The Classes**

As an observer, each of these three classes seemed very different from one another. A description of the first ten minutes of a typical class, along with the words of the teacher, provides some insight into each.

**Ms. Flanders.** The bell rings and almost all of the students are already sitting in their assigned desks. On the overhead projector is a class starter, although the students do not immediately begin on task without prompting from Ms. Flanders, who is standing in the doorway speaking with someone. As she comes in she politely asks the class to get started with the assignment. The sounds of backpacks opening and papers shuffling are the only responses. A few students chat quietly as they begin to work, but Ms. Flanders redirects them by simply calling a student by name and asking if she is working on the assignment and makes a joke with one of the students. The class falls silent as they work on the assignment, and the teacher enters attendance into the computer system. Another assignment is on the board for students to begin if they finish early. Ms. Flanders takes her cue from the escalating volume of whispers that many of the students have completed the starter. After a brief review of the starter, Ms. Flanders passes out a worksheet to review the naming of compounds. Students pair off and begin the sheet. She quickly
goes over the day’s agenda. Noticing a conversation among three boys, the teacher calls one by name and asks if he is working, to which he affirms and stops talking to the others in his group (from Field Notes 11/22). In describing this gifted class, Ms. Flanders said:

I guess I should say the good things first – they’re all really sweet. I don’t really have any discipline problems. They do talk too much; they’re very social. That’s the worst. I have three kids in there that routinely fail tests, so I am kind of surprised they are in the gifted program…. They catch on easily…. I don’t have the same discipline problems…. With the gifted class, they’re Ok, because they’re small (class size) and much more accountable for what they do. (Interview 9/5)

Ms. Botz. After the bell rings, Ms. Botz reminds the class of the starter assignment that is written on the board and begins passing a handout to the class. A few students are still getting settled into their seats. The school announcements come on during the beginning of this period, and the teacher has to loudly remind the students to be quiet during these. As Ms. Botz finishes passing out the handout, she goes into the lab storage room for a moment. Upon returning, she has to quiet the class once again. Several students are up walking around the class getting some colored pencils from a box at the side of the room. A female student has moved to the back of the room to talk with a male student; Ms. Botz asks her to stop talking and move back to her desk. As the announcements end one student asks if he can write on the handout they were given; another asks what they are supposed to be doing. Ms. Botz tells him she made that announcement at the beginning of the class. In quiet protest he says that he never got the
sheet they were assigned, and the teacher gives him a copy. Most of the other students are either working on the assignment or gathering the colored pencils they need to complete it. Although there is quite a deal of noise in the class, the vast majority of the students are engaged in their assignment. Ms. Botz takes care of some administrative duties, such as attendance, while the class works on the handout (From Field Notes 11/19).

Compared to Ms. Flanders’ class, Ms. Botz described this class as requiring a little more attention:

I have a lot of...they’re good for short periods of time, but if you don’t just stand right over them with a very tight rein they can get out of control really quick.... The biggest problem that we have at this school is the Alpha kids (Note – this pseudonym refers to the short-term foster home system that Ms. Botz later describes. Students from this home are only enrolled for short periods of time, usually only several weeks.) that kind of feed in. They’re only here for a short-term basis, but sometimes one can throw off the personality of the whole thing because they are trying so hard to fit in so quickly. That’s hard, because it changes - Now I’ve got this new Alpha kid and that just went to pot, so then you have to shift everybody back around.... It seems like every now and then they’ll get a kick of energy right at 4th block. They’re either dead to the world or they’ll get that kick of energy and just drive you up the wall. (Interview 9/4)
Mr. Burns. After the bell rings, Mr. Burns asks the class to grab a seat and that they should begin working on the class starter on the overhead. About half of the students are seated, and another student (not in the class) comes in and starts looking for a book bag that she left there. As a few others get seated, two male students remain standing and walking through the room this entire time. While the teacher deals with the girl’s book bag search, the classroom gets louder and louder with noise. A couple of students work on the assignment, but most others have yet to get a sheet of paper out. A male student walks through the room turns off the overhead projector. Mr. Burns turns it back on and asks the student why he did that. Another student asks to go to the gym, with no success. Walking around the classroom, the teacher prompts individuals to get going with their assignment. After one female student asks a question, Mr. Burns decides that he needs to go over this with them as a group. “My guess is that if I collect this, no one will have it. My job is not to fail you, but to help you learn.” He goes over the first two questions from the activity with the whole class. A male student walking around looking for a pencil distracts Mr. Burns. “You need to come into class prepared.” A couple of male students make lewd comments to the female still in the class looking for her bag. Mr. Burns finishes going over the starter activity and transitions to the first activity for the class (From Field Notes 11/19).

Mr. Burns obviously had more non-educational student activity in his classroom, and more behaviors to redirect toward his learning objectives. Describing his class:

I’ve taught plenty of physical science classes, but this is the first that has been grouped homogeneously like this. By far, the most difficult classes I’ve taught…. 
I have 6 students passing out of 65; they’re going to have problems with the
textbook and everything in it…. A good 80% of them have no idea of what is
going on – grades in the 20s or 30s, and are constantly asking me, “Did my grade
come up? I did my worksheet today.” They just have no clue. Several of those
kids are just waiting to drop out. It’s a difficult environment when you have that
many kids and half of them are this and half of them are that - don’t care, can’t
read, just there to cause trouble, just there to sleep because they don’t want to be
at home…. You’ve got students that are so animated that you love them and
they’re the same kids you throw out of your class three times a week. That class
almost kills me some days. (Interview 9/9)

From both the description of these classrooms and the words of the teachers, it
seemed evident that there was a great deal of variance in the behaviors of students in
regards to classroom management. The classroom of Ms. Flanders was fairly orderly;
she had to do very little in terms of keeping the students engaged in their work. At the
other end of the spectrum, Mr. Burns constantly dealt with distractions and low
motivation in his class. In between these two is Ms. Botz, who often had a lot of noise in
her classroom although students were usually engaged in their assignments.

It was not the goal of this research to isolate the exact factors that led to such wide
discrepancies in classroom behavior across the same subject. For instance, basic
characteristics about the teachers may have had some effect. These three teachers
differed from one another in gender, age, experience, and educational background. In
addition, other factors such as the student academic level or class period may also have
had an influence (Ms. Flanders’ class was 2nd period, Mr. Burns was 3rd, and Ms. Botz was 4th). However, the research questions addressed here pertain to the beliefs held by these teachers.

Beliefs Pertinent to Classroom Management

Throughout their interviews these teachers expressed a wide array of ideas and beliefs about managing their classrooms and facilitating student learning. In narrowing these down to the most common across each of the three participants, the list shrunk to four topics that seemed to be among the most influential relevant to answering the question as to why these teachers managed their classes the way they do. These four factors differed across the three participants, despite the similarity in content area. Of these four, the characteristics of personality and perceived role related more to aspects of the individual teacher. The other two, physical classroom environment and student characteristics, seemed more beyond the control of the teacher, but greatly influenced the dynamics of the science class. The combinations of these four factors together created quite different environments in the three Physical Science classes.

From these participants’ interviews, a great deal of what shapes the direction of the classroom appeared to be the teacher. These participants shared that a teacher has a basic personality that affects how he or she structures the class and determines to a large degree what behaviors are acceptable. Additionally, these teachers had taken on a perceived role that they envisioned the students have for them. Though these two factors were obviously related to one another, it was fairly easy to separate them for the purposes of illustrations.
Personality. Despite their differences, one similarity between these three teachers was that they enjoyed working with their students and believed that their personality was important in having success as a teacher. They each wanted to help their kids to achieve a variety of things. Asked why teaching suited her, Ms. Flanders replied, “I like talking a lot. I like kids” (Interview 9/2). In providing a list of characteristics that a teacher must have, she included ‘understanding’, ‘sympathetic’, ‘caring’, and ‘able to counsel worried souls’ among the descriptors (from Model of Teaching). These aspects of her personality came out during her classes. Ms. Flanders often spoke with individual students about things other than science (from Field Notes). Additionally, she would joke around with them during discussions and other class activities, although she was still quite firm with students about rules and expectations when needed. Ms. Botz more directly addressed the issue of her personality in the classroom:

…and granted, I may be too much lenient – but they (other teachers) want them to be perfectly still and perfectly silent and that’s just not my personality. A lot of your personality has to come through. (Interview 9/2)

She wanted her students to be actively engaged with the content in the class. It is apparent that her choices of hands-on and cooperative activities in class stemmed from her personality style. She enjoyed talking with and interacting with the students and designed activities and class schedules to accommodate that (from Field Notes). In addressing how her personality related to her choices in the physical science class, she added:
I think it all has to do with the attitude of the teacher. I try desperately everyday to come in and just be as full of energy as possible, and try to get the kids moving and interacting and not putting so many walls around what they can and cannot do, to make them to feel as comfortable as possible. (Interview 9/2)

In allowing her students more freedom for moving and talking, Ms. Botz continually performed a balancing act of keeping student activity at a level that was comfortable for her, but also was able to support their learning. In order to achieve this, Ms. Botz did a great deal of monitoring during classroom activities:

Usually I don’t like for them to talk while I am talking because usually I don’t try to talk to them that much. There’s some classes that have really strong peer groupings and they’ll do the work as long as you let them work together…. My problem with talking is about production - if I don’t see production, then the talking ceases. I remind them, and try to reinforce it as much as possible, that lab time is noisy time. So, we have quiet time, noisy time, quiet time….Sometimes it can get a little loud and that’s when you have to go sit by them or break them up, or whatever….You call them on it. When they say that we can talk and work at the same time, you go by and check on it. “No, you’re not working, you’re talking so you need to break it up and let’s get some work done.” (Interview 9/2)

Mr. Burns shared a great deal in common with Ms. Botz in expressing the role of his personality in the classroom:
I have a relaxed, and sometimes too relaxed atmosphere in the classroom. That’s my personality. That allows me to have a lot of fun…. The first thing that you have to do is to develop your own style and don’t try to be someone else…. If I came in here and I tried to be extremely strict – everybody’s going to sit down- I can’t do it. I don’t, I can’t do it. So, yes, I am going to modify it on the needs of the class, but I am still me, and my classroom is going to be a little more laid back. (Interview 8/29)

Thus, a great deal of what influenced behavior in the classroom came from this basic personality or style of the teacher. Despite similarities in the personalities of these three teachers, the classroom atmosphere of each was often quite different from one another. For example, both Ms. Botz and Mr. Burns mentioned that it was not in their personalities to prevent their students from moving around the class or talking, but the students in Mr. Burns’ class seemed to step outside the boundaries of behavior that were typically expected in a secondary school classroom. Although a great part of the personality of these three teachers was their desire to interact with their students and to foster an atmosphere that was not repressive, there were other factors that additionally contributed to the management of their science classes.

Perceived Role. Another factor for these three teachers that was related to their personalities was their perceived role in relation to their students. Not only did these teachers have a personality, but they also took on a persona in order to relate specifically to their students. This aspect was related to research about teacher metaphors and their relationship to classroom practices (Tobin, 1990). For both of the female teachers, the
role was that of ‘mother’. For example, Ms. Flanders mentioned, “I think they think of me as more of a mother. I’ve had kids call me mom before, mistakenly” (Interview 9/2). Part of her job is to look out for her students like a mother might, “Until these kids get out and on their own, I kind of feel like we’re taking care of them” (Interview 9/2). Though she did not specifically use the term, the image of ‘mother’ was conjured by Ms. Botz when she said that she was able to meet some of her students’ needs:

I also have to remember that sometimes I am the only bright spot in their day. I’m one of the only people that harasses them – ‘Why didn’t you do your work, why didn’t you do this, why didn’t you do that, why are you doing that, why are you making such bad decisions?’ Their parents just really don’t care about them. (Interview 9/2)

This quote from Ms. Botz was interesting in that she did not explicitly mention assuming the role of parent, but she did contrast her own behavior with the behaviors of her students’ parents. In particular, her words pointed out that she believed that students needed someone to push them. For her, “harassment” was a positive thing since it indicated her concern about their decision-making.

Ms. Botz and Ms. Flanders both saw their students as having needs in addition to helping them with their science content knowledge. Their role as a teacher was to address perceived shortcomings the students had in other aspects of their lives. A belief that students were missing out on supportive family structures led these two women to
adopt a motherly role with the students. Ms. Botz felt that being able to take on this motherly role had advantages for female teachers compared to males:

I think that we have some advantages over males because a lot of these kids are looking to be nurtured, and so me hugging and patting, and looking at someone and saying, ‘you’re being so goofy’. Kids, especially male students, don’t think of it as a threat, and female students don’t think of it as flirting. (Interview 9/2)

Being of a different gender and closer in age to his students, Mr. Burns views his relationship to his students as more of a peer:

I think I have a lot of things in common with a lot of these kids, and that has made a huge difference. They’re always into sports, and I would play basketball with them every period during my planning period over in the gym… I want to have stuff in common with them and want to share my stories to show that I am similar to them, but you just have to find the line where you’re still doing your job and you’re still putting a priority on helping them pass your class and helping them get out of school as opposed to helping them have a good time…..I think kind of being buddies with them helps. (Interview 8/29)

Mr. Burns often related to his students in ways he perceived them relating to one another. For example, he did not shy away from joking around or using sarcasm with his students
in ways that were more representative of typical student-student interaction. When asked about this aspect of his interaction with students, Mr. Burns’ rationale was enlightening:

Those kids come in the door with a smile on their face already trying to jaw on me. Yes, it’s disruptive sometimes, but I would rather have those kids be kind of, not friends because I know they’re not friends, but have a positive outlook on me. They’re not going to pass anyway, so I would rather be buddies with them than have them hate me and have them disrupting my class all day. (Interview 8/29)

It seemed that Mr. Burns believed that interacting with his students on more of a peer level had a powerful influence on positive classroom management.

None of these three teachers wanted to act in a way to inhibit social interaction in their classrooms. Each had basic beliefs about their personality that valued communicating and getting to know their students. Because of this, they were highly unlikely to demand silent, placated students. Additionally, they saw these students as having added needs that they were able to fulfill by taking on the role of mother or friend. As a mother, they were able to deal with the emotional and nurturing needs of the students. As a buddy, Mr. Burns wanted the students to see him as similar to them, both as a way to fulfill the needs of his own personality and to “build(s) trust, (so) hopefully you can turn that around in the classroom if you have some of these students, and they will be more willing to listen to you” (Interview 9/9).

Observing the interactions of these teachers with their students over the course of the semester hinted that the two women were more comfortable assuming the role of
Inconsistencies in some of the interview data from Mr. Burns indicated that his perceived role was not as pragmatic as it was in the past. As will be discussed later, the characteristics of the students in his classroom were much different during the course of this study compared with those in his previous years of teaching. Though he mentioned that he liked to have a relaxed classroom so he could “have a lot of fun”, it was apparent as the semester wore on that Mr. Burns was often not having fun with his students because of their tendency to gravitate toward disorder. In order for Mr. Burns to better manage these students, his perceived role may need to be altered (Tobin, 1990).

The combination of the teachers’ personality with their assumed classroom roles shaped a great deal of the management environment of the classroom. All three teachers came across as caring a great deal about their students and employed similar teaching strategies. Despite these similarities, the frequencies of off-task behavior in these three environments ranged from rarity with Ms. Flanders to frequently with Mr. Burns. Along with these features related to self, it was likely that additional factors were responsible for contributing to the differences in classroom behaviors and management with these three teachers.

In contrast to the beliefs described above, other factors prominent in classroom management related more to aspects beyond the personal control of the teacher. Whereas personality and perceived role were variables that the teachers bring with them to the class, the physical classroom environment and the students enrolled in a course were features of which teachers had little personal control. Both, however, seemed to play crucial roles in issues of classroom management for a secondary science teacher.
Physical Classroom Environment. These teachers felt that how they arranged their classroom, combined with drawbacks of the classroom design, significantly affected what went on in their rooms. Ms. Flanders and Ms. Botz, whose rooms were side by side, had student desks arranged in straight rows facing the front of the room. Lab activities occurred at the sides of the room on counter tops. Asked why she positions her desks facing toward the front, Ms. Flanders offered:

I’ve turned my desks different(ly) and had them face each other instead of, the front of the ship metaphor, where you are the captain. And then I changed them back because I was having problems with behavior, so they’re all facing the front again. (Interview 9/2)

Through experience, it appeared that the arrangement of students in the classroom had an effect on the behavior of students. To deal with this, Ms. Flanders changed seating arrangements in her class every two weeks or so (Field Notes). One problem in moving away from having students sit in straight rows was their difficulty in adapting to design changes:

I guess because when we are brought up as little kids we still are in that traditional little dictatorship, so that when kids are put in a situation where they don’t have that they don’t know what to do. So, I think it’s a pretty traditionally set up. (Interview 9/2)
On the other hand, Ms. Botz would simply preferred more space in her class: “I just wish that, in my perfect world, in my ultimate classroom there would be more space, more ways to incorporate all the stuff they need to know, all the stuff that needs to be covered…” (Interview9/4). Both she and Ms. Flanders had problems with the lab stations along the edges of the room, each with a different reason. For Ms. Flanders, “They’re around the sides of the room – it’s so crowded” (Interview 9/2). Ms. Botz, who is shorter than many of her students had a more personal reason:

I hate the lab stations I have in my room right now because for them to work and for me to move throughout the room I am looking at their backs. I would prefer to have a station where, as I’m walking down I would actually get to see the front, actually get to see the stuff. The space in my room is pretty small, so it’s like a little student wall and I have to peer over their shoulder. (Interview 9/2)

In both cases, the way that labs were conducted in the class was affected by the positioning of immovable classroom objects. Additionally, students were up moving around, presenting a large amount of interaction that needed to be monitored. These aspects, somewhat unique to science classes, presented management challenges in these classes. Mr. Burns pointed out that managing lab sessions was a skill unique to science teaching: “Managing your classroom when they’re all in chairs is very different than managing when you’ve got 30 of them up, wandering around and you’ve got fires all over the place” (Interview 9/2).
During the rest of class while students were at their desks, the two female teachers had the freedom to position students wherever they desired. Because of this, some discipline problems were averted because students were able to be isolated from one another. Ms. Botz’s addressed the issue of separating groups of students who talk with one another quite a bit, “Space out the ones. I call it four corners. Usually there is a group of four that is the core of your troubles – just four corner them; make sure there’s four corners in your room” (Interview 9/9). The arrangement in Mr. Burns’ class was quite different and posed management problems that were difficult to overcome by the strategy Ms. Botz advocated:

We have fixed tables that are fixed to the floor, with three or four students per table, so I don’t have a whole lot of freedom in how I organize that. I thought it was great for biology but I think it’s horrible for physical science. You have half of the classroom with their back facing you…. I’ve got enormous amounts of talking going on this year at these little tables…. I’ve tried moving kids around in different seating charts, but there’s so many people in there I can move a kid to 5 different tables and he would have somebody to talk to just as loud as where I moved him from. I don’t have enough room to spread them out. (Interview 9/9)

The physical setup of the classroom posed unique challenges for each of these teachers. Although not mentioned by any of the teachers, each of these classes averaged about 20 students during each observation. Had the enrollment or school attendance of their students been higher, these frustrations would have possibly compounded, as space
became a more precious resource. There was little that can be done about these constraints, leading the teachers to do the best they can with what resources were available.

**Students.** The last main factor from the interview data influencing classroom management was the student. Like the physical arrangement of the classroom, this was an area where teachers had little control. Students and classes were assigned to teachers and they must work with whoever happens to be in them. Although the teacher may be influential in reaching individual students, these participants’ words supported that their students, as a whole, shared a great degree of characteristics. These beliefs, in turn, impacted upon what instructional and behavioral decisions were made in the classroom.

One belief these teachers shared about their students was a general lack of motivation, although Ms. Flanders seemed to voice this the least when she said, “…because they go nuts, because they don’t really care. They would rather goof around” (Interview 9/2). The other two teachers seemed to voice a greater concern about a lack of desirable traits, such as responsibility and motivation. Ms. Botz felt that many of her students did not have any personal responsibility because of how they had been treated by schools in the past, “You will see that they have been socially promoted at every grade. So, they don’t know how to be held accountable for their actions, and that is really a disservice” (Interview 9/9). In terms of motivation, “…(G)eneral, run of the mill kids are not going to come to you dying to learn. They are going to dread coming in because a lot of people hate science” (Interview 9/9) Mr. Burns echoed this in describing how responsible his students were, “These kids break and can’t even handle the most basic and indestructible lab equipment that we have” (Interview 8/29).
These negative attributes associated with their students affected science teaching in a variety of ways, especially when it came to working on labs or other hands-on activities. Each of the teachers described how they counteracted the possible irresponsibility of their students:

Ms. Flanders: So, I don’t trust them with much. With 9th grade I don’t do a long lab. They’re more like demonstrations; they aren’t true experiments, that’s for sure. They don’t use fire because I don’t trust them. They burn stuff. They burn each other. I think they’re good, but I don’t think they get out of it what they should. And even if I try to go over it afterwards, sometimes they are so hyped up that they don’t get it anyhow. They just want to write the answer down. So to have them summarize it or apply it, I hope that works. (Interview 9/2)

Ms. Botz: And then, the biggest thing is limiting their access…for example, we did physical and chemical changes, and they had to tear up a piece of coffee filter, put it in a watch glass, and burn it. So, I don’t say in the materials like ‘a box of matches’. When it gets to that point I say go get a match from the teacher so I know that your group is about ready to go burn so I will walk over there. So, you kind of are already there at the dangerous part. When I say a match, that’s what they get – a match. Don’t ever give a box of matches because you might get (only) one back. (Interview 9/2)
Mr. Burns: The younger and more immature the student, the more direction, guidance, and lack of flexibility I am going to give them. Safety is important and is a key rule in regards to how it’s managed. I will let some kids play around with the stuff even though they’re not following the directions of the lab if they are doing it in a safe manner. I would rather have them interested than just sitting down sleeping or something. (Interview 9/9)

This last sentence provided by Mr. Burns shed some light on the tensions experienced by these teachers as they managed their classrooms. On the one hand, they each had a personality that valued interaction. Additionally, they believed their classroom should be student-centered with students interested in their science classes. Working against this was the belief that many of their students did not handle these types of situations very well and needed a great deal of guidance in following through with many of the activities they undertook in order to complete them in a timely and safe manner.

Discussion

Trying to get an understanding of a secondary science classroom is a very complex undertaking. Each teacher has a unique background and history that contributes to her actions in front of a group of students. The personality that has developed over decades of life shines through in how interactions are played out. Teachers come in a variety of ages, genders, shapes, and cultural backgrounds. They carry additional names, such as ‘mother’, ‘father’, ‘coach’, and ‘son’. All of these must somehow influence the reasons that teachers engage in their chosen classroom behaviors.
Despite this complexity, classroom management is an area of high importance in teaching. Those who are deemed to have poor management skills by their supervisors may be required to seek additional training during breaks. Introductory science education texts include classroom management as a major section (Hassard, 1992). Science education methods courses address the topic, and many neophyte teachers rank it at the top of a list of their concerns about becoming a teacher (Tamir, 1991).

So how do we teach classroom management? Returning to the context of this study, pre-service teachers enrolled in their introductory science education methods and curriculum courses worked with each of the teachers in this study. By all accounts, the pre-service teacher would likely have spent approximately 75 hours within the classroom observing the dynamics and interactions between teacher and students. What would he or she have learned about classroom management from these observations?

The student in the classroom of Ms. Flanders would have seen a teacher in the middle of her career who enjoyed working with students, was knowledgeable about content, and kept a fairly strong degree of order among her students. Students were encouraged to work together quite often and usually exercised a great deal of control as they worked through their activities. When working alone, it was sometimes silent in the classroom for significant amounts of time. By all accounts, this would be considered by many to be a well-managed science classroom.

In contrast, many might consider the classroom of Mr. Burns to be poorly managed. Students were often disinterested in what activities and lessons were assigned. Individuals moved freely around the room, individuals entered and exited the class throughout the period, and students were often seen sleeping during certain times.
However, Mr. Burns desired for his students to achieve and worked hard with those students he perceived as interested in doing well in the course.

For a pre-service teacher observing only one of these classes, he or she might develop some ideas about the factors that led to the environments found in all three. An individual working with Ms. Flanders might attribute order to the experience the teacher has or to the fact that the students in that class were considered gifted and more interested in academic achievement. The disorder found in Mr. Burns’ class could be chalked up to his relative inexperience and youth. His students were, by and large, not interested in doing well in his science class. Thus, his initial challenge in creating order in the class was likely stronger than that found in the classrooms of the other teachers in the science department.

In reality, all of these issues (and likely others) worked together to create the management atmosphere of the particular science class. In returning to variables previously mentioned that influence student behavior in the classroom, it is possible to identify how these additional factors differ across the three classrooms and to what degree each seemed to contribute to the amount of disorder with each teacher. For example, Burns (1984) showed a connection between student behavior and the types of learning activities used by the teacher. Although there was a great deal of discrepancy between how students acted with each teacher, the types of activities used were very similar. Each engaged students with a range of strategies, from hands-on activities to individual seatwork. The one major difference between the three classrooms in this regard was that there seemed to be more “down time” in the classroom of Mr. Burns. Students in the classes of Ms. Botz and Ms. Flanders seemed to have less opportunity to
get off task. One influence on this may have been in the course design, where students in Mr. Burns’ class were scheduled to take the Physical Science course over the entire academic year, while all of the others completed the course in an 18-week semester. Perhaps the rationale of allowing “at-risk” students to move at a slower pace may backfire as science teachers find difficulty in altering their traditional approaches to teaching such a course.

An area where these teachers may have made known different expectations for student behavior was in their own behavior in the early portion of the year (Evertson & Emmer, 1982). Specifically, Mr. Burns indicated during the middle of the semester how his permissiveness early in the school year caused problems for him later in terms of classroom management:

Everybody starts out the year with rules and regulations that would be just fine, but if the kids start pushing you and seeing what they can get away with, you’ve got to be consistent and follow through with your rules. I’ve learned that the hard way this year. I went through about a month or so where I didn’t follow through with my consequences and now I’m going to have to turn over a new leaf and pick up some of those new rules again, and it’s helping out a lot. (Interview 8/29)

In contrast, the two female teachers in the study seemed more consistent throughout the school year in how they handled student behavior. As is apparent in the words of Mr. Burns, the students likely begin to realize what behaviors they “can get away with”. When teachers have to suddenly implement new behavioral expectations on
students during the middle of the school term, the transitional period can be difficult. This was observed in Mr. Burns’ classes as he tried to become more structured in terms of how he expected students to conduct themselves. In practice, he had to become stricter than he was comfortable in order to bring student behavior to a level that was acceptable to him. Whether he was successful at this was not readily apparent.

A third area in the literature that links teacher actions with student behavior was in the types of interventions teachers use to address student misbehavior (Erickson & Mohatt, 1982). Observations of classrooms indicated that the three teachers did not differ readily in the types of interventions they used. The three would hold students after class, remove them to an in-school detention setting, move students to another seat, or simply speak with students during class in attempting to modify behavior. However, similar teacher behaviors would not always equate with similar student changes. Approaches used by Ms. Botz and Ms. Flanders were generally more successful in achieving a desired behavior than the same ones used by Mr. Burns. Classroom observations suggest two reasons for this phenomenon and would seem to provide insight as to why this was the case. First, as previously indicated by Mr. Burns’ own words, he was inconsistent in his use of approaches to modify behavior. For example, Ms. Botz and Ms. Flanders would typically always address what they considered off-task actions or misbehavior, whereas Mr. Burns was much more sporadic. Also, he was less likely to follow through with his chosen consequence if the students’ behavior continued. Secondly, the same consequences did not always affect Mr. Burns’ students the way that it might for those with Ms. Flanders. The strongest immediate consequence for a student in these classes
was to be sent out of the room for in-school detention. Mr. Burns indicated that this was not really a concern for most of his students:

It’s not really a big threat to them anyway. It’s more just for me to have them out so I can somewhat move on. They don’t really care, most of them don’t. A lot my kids would like to be somewhere else besides my classroom. (Interview 8/29)

This differs from the gifted students in Ms. Flanders class who would generally respond to simple verbal redirection by her. They seemed to care more about staying out of “trouble” and keeping their grades up. Compared with Mr. Burns’ students, they seemed like they preferred being in the classroom and getting good grades. Thus, minor attempts by Ms. Flanders to modify behavior were generally effective.

Despite the difficulties in classroom management for Mr. Burns, it was his classroom that was perhaps the most illustrative of the complexities in establishing order in a secondary science class. Interviews and informal time spent with the teacher indicated his frustrations he often felt in trying to teach his students. Where Mr. Burns seems to struggle with management issues with these particular students, his approach to teaching may flourish with others. In fact, he was quite up-front about the difficulties he had working with this group of students as compared to previous years, “I’ve taught plenty of Physical Science classes, but this is the first that has been grouped homogeneously like this. By far, (these are) the most difficult classes I’ve taught” (Interview 8/29).
Although there is no research data concerning Mr. Burns’ classroom management prior to the semester of the research, it was inferred that his level of frustration was lower in the past. It is unlikely that he made drastic changes to his style of teaching for his fourth to fifth year of teaching. Thus, the most likely culprit for the challenges faced in creating order was in his students. The other three factors developed in this research (personality, perceived role, and classroom environment) were likely the same over both years. The restructuring of the Physical Science course, however, filled his classes with students who had a history of low achievement in their academic past. The classroom management style that seemed to have worked more effectively in the past was inadequate to create the environment that he wanted with these students.

**Implications for Site-Based Courses**

Despite the research that has contributed to our understandings about classroom management, the issue of how pre-service teachers learn about classroom management seems fairly underrepresented. For some, it seems that certain aspects of teaching, such as classroom management, are best learned in the classroom (Lave, 1996). Part of the rationale for developing a site-based Methods and Curriculum course such as the one described here is to increase the exposure to students with complexities like management. Without research participation from the pre-service teachers in the course, it is difficult to understand what they took away from their observations of the partner science teachers at the school. Undoubtedly, their experience of being at the school throughout the semester allowed them to better understand many of the dynamics present in the classroom compared to a typical two or three-week practicum experience. However, developing the course so that the pre-service teachers are better able to examine the management
situations of all host teachers may help them to gain greater understanding of classroom complexity. Seeing various teaching personalities, teaching methods, and student characteristics across age, gender, and ability levels might provide insight to the pre-service teachers about practices that contribute to order and those that do not.

In developing a site-based Methods and Curriculum course, a couple of suggestions could lead to better understandings of classroom management. First, the act of observation alone likely does not provide the amount of insight that would be gained were pre-service teachers able to engage in meaningful dialogue with their partner teachers about their general teaching beliefs. From a research perspective, many of the actions of teachers were better understood through conversations and interviews with these teachers. Likewise, pre-service teachers could pursue the question “why?” to their partner teachers after their observations, leading to a much deeper understanding about the decisions made by the teacher during the course of the class. Though these types of interactions likely happen to varying degrees with each mentor/apprentice pair, course assignments for the pre-service teachers could work to ensure that this is more commonplace.

For example, on a couple of occasions, Mr. Burns often allowed behaviors to go unchecked during the course of an activity. The casual observer (or the researcher) might conclude that the teacher simply lets the students walk over him and do pretty much as they please. Understanding his thinking, however, leads to a number of possible reasons for allowing a behavior to continue. Mr. Burns might know the student on a personal level and knows of a difficult time the student is currently having. He may let it persist because he wants the student to have a positive experience and have fun in the science
class. Perhaps the most severe consequence that Mr. Burns can provide (removal from class to a detention room for the remainder of the class) will not deter future behavior problems. It is possible that Mr. Burns might not even notice the behavior since certain things “don’t grate on my nerves that much.” Additionally, the pre-service teacher may come to realize that the partner teacher is still struggling with the issue of classroom management. In this case, having this lower quartile of students proved to be a formidable challenge to the teaching beliefs that he developed up to this point and that he has to constantly reassess his actions and expectations with this different group of students.

Without engaging the teachers about their management practices, much of the decision-making process remains implicit to the pre-service teacher. An important activity that might help further this understanding would be to assign a specific interview script to the pre-service teachers and have them interview their partner teachers. These pre-service teachers often interview secondary students to gain some insight about learning. Extending the interviews to learn more about teaching should prove helpful, as well, especially if teachers were interviewed about specific actions that were observed during their practices.

A second possibility would be to assign pre-service students a review of classroom management of their partner teacher. In such assignment, the pre-service teacher would be responsible for videotaping segments of classroom interaction with the partner teacher and his/her class. This video would be shared with the rest of the pre-service members during classroom meetings. The pre-service teacher might provide a commentary and insight as to what he or she perceives as the important factors
contributing to the order or disorder in the classroom, with others being able to share and reflect on their ideas as they viewed it with the group. Sharing these videos with the larger group would expose all pre-service teachers to the teaching and management practices of every faculty member, providing a broader idea of the complexities of classroom management. Being able to see the classroom differences in regards to factors such as the students might challenge existing beliefs about classroom management held by the pre-service teachers. Additionally, identifying characteristics across the various classes should support good management practices identified in other research.

From this perspective, simply placing pre-service teachers in the classroom earlier in their education is a good start, but including additional assignments could help make this more meaningful. Adding course projects such as those described above would provide greater emphasis on the characteristics of cognitive apprenticeship. Having pre-service teachers experience (even in a limited way) the classrooms of other teachers through videotape would broaden the “social setting” aspect of the model beyond the classroom to which each student is assigned. Finally, creating greater dialogue between the pre-service teachers and their host teachers would provide greater understanding of the reasoning used in making certain management decisions observed in the classroom. With classroom management an important concern for new teachers, teacher education practices that promote quality management should be identified and supported through research. If a cognitive apprenticeship model of teacher education is thought to facilitate management, longitudinal research among students in both traditional and site-based methods courses would help identify the lasting results of these experiences. Additionally, feedback from course participants in site-based models could help identify
which projects seemed more helpful than others in developing their ability to better manage classrooms.

References


CHAPTER 5
SUMMARY AND CONCLUSIONS

Introduction

The goals of the research presented in the previous four chapters explored and voiced the professional beliefs and practices of secondary science teachers within the context of a creative teacher education experience. In doing so, the data helped to understand those aspects of teaching that were at the cognitive forefront of experienced secondary science teachers. Additionally, the study was geared from a practical standpoint to help inform the design of subsequent site-based Secondary Science Methods and Curriculum courses. Since these courses used a cognitive apprenticeship model, emphasizing the experienced teachers as experts and mentors, explicating their beliefs about teaching is important to pre-service teacher education in this context.

The data and research presented in the previous three chapters illustrated the broad aspects of these teachers’ beliefs about being a science educator. Chapter Two, for example, showed how a variety of concepts influenced how each teacher thought of his or her job. Additionally, specific parts of science teaching, such as inquiry and classroom management, illustrated the complexities inherent in meeting specific goals in the science classroom. From a synthesis of these chapters, conclusions were drawn to the research questions presented earlier.

Secondary Science Teachers’ Beliefs About Science Teaching and Learning

Stated in the most general way, this research was guided by a desire to add to the accumulating body of knowledge regarding the professional beliefs and actions of
practicing science teachers. The methodology of the study allowed for in-depth interviews and observations about each of the six participants. Because of the limited number of participants in the study, it was not the intent of this summary to generalize conclusions to all secondary science teachers. It is recognized that these science teachers were unique and have individual histories that have shaped their views and beliefs about their job. Despite this limitation, the information provided by these participants was helpful in gaining a more detailed understanding of the thought processes of secondary science teachers in a public high school. Their thoughts may not be representative of all science teachers, but the issues brought up are likely relevant to secondary science teaching in many different contexts.

Constraint

The data, especially the interviews, from these teachers pointed to a number of constraints in their job that seemed to prevent them from reaching an ideal state in the classroom. In Chapter Two, participants noted the number of competing roles required of them in their life at school that went beyond simply helping students learn science. In addition to meeting the educational needs of their students, these teachers also felt compelled to meet emotional needs, as well. In the following chapters, other constraints, such as time, student characteristics, and the science curriculum each worked against the way the teachers would like to conduct their classes. If these teachers were allowed to magically alter aspects of their teaching environment to create a more positive learning atmosphere, each would change something. As a part of the initial interview, each teacher was asked to describe his or her ideal teaching environment (see Appendix B). None indicated that he or she was totally happy with the status quo. At points throughout
the interviews, a variety of constraints were mentioned that kept their science teaching from aligning with their conceptions of how science teaching and learning should occur. Three areas of constraint seemed most prevalent.

The first of these constraints is the issue of curriculum. In reality, the curriculum is only problematic in those subjects where students were required to pass a state-mandated test. Thus, conversations with teachers of Biology and Physical Science (the content areas covered in state science testing) indicated frustrations with the curriculum. Interviews with Ms. Quimby (who taught Ecology) and Ms. Gumble (Chemistry) failed to illicit the same dissatisfaction with the state curriculum they taught. Nevertheless, even these two teachers spoke with frustration about the other courses, especially Ms. Quimby in noting that the Biology curriculum was simply too large to be adequately taught.

The majority of these teachers had been in education long enough that they have experienced science teaching both before and since the advent of statewide testing. These teachers, especially Mr. Hibbert, were open about how such testing has affected the way they sequence, plan, and teach the course. Prior to testing, a teacher could spend as much or as little time as he or she chose in covering particular aspects of the curriculum. However, as testing began, there was a need to make sure every tested objective was “discussed” during the class, even if this discussion were to the detriment of the students’ learning. For example, Mr. Hibbert related how he now went into much greater detail now about content areas such as ‘photosynthesis’ to make sure his students have as much exposure as possible to all of the curriculum-related test questions associated with it. As he felt the need to spend a greater amount of time on reviewing
vocabulary, he related that the relevance of the science to the students’ lives diminishes, possibly resulting in negative affective changes with his students.

A second area of constraint for these science teachers was found in issues related to time and their other non-teaching job responsibilities. Beliefs about being a science teacher were much broader than a somewhat traditional notion of an individual who worked to pass on science information to students. These teachers often found themselves taking on a myriad of additional responsibilities at the school. Some of these responsibilities were taken on a voluntary basis (e.g., coaching cheerleading), while others were mandatory (e.g., patrolling the student parking lot prior to school). Regardless, all took away from their formal initial responsibilities of helping their students learn science in the classroom.

Teachers were involved in extracurricular activities, such as sports and clubs. Ms. Botz, for example, sponsored the cheerleading squad, and Mr. Burns referenced his willingness to one-day act as the school’s tennis coach. Teachers had to serve on a variety of committees in order for the school to function properly. During the research, Mr. Hibbert and Ms. Flanders worked with teachers at the middle and elementary schools to align the science instruction across the grade levels in the district. Teachers must participate in Student Support Team meetings, as required by state policy, for their students who are showing academic difficulties. Throughout the year, each teacher was assigned to monitor the behavior of students in hallways, restrooms, and parking lots. Despite the allocation of a 90-minute planning period each day, a great portion of this time was often eroded by tasks associated with these non-instructional duties that were still essential to performing the job of a science teacher.
This belief about a perceived lack of time results in a number of consequences for the classroom. These teachers placed value on efficiency in a variety of areas. First, relating back to issues of curricular constraint, there developed an efficiency of instruction. Learning tasks and teaching strategies were used that produce the greatest content coverage in the shortest amount of time. Secondly, the pursuit of novel teaching and learning activities was minimized because of the time required for these other teaching duties. Teachers found it difficult to initiate new ideas and projects in the classroom when a great deal of their “free” time was spent contacting parents, sitting in committee meetings, or completing required paperwork.

A third area of constraint was with the students and parents at the school. These teachers placed a number of attributes and characteristics upon their students that constrained them from developing an optimal teaching and learning environment. These teachers often saw their students as poorly motivated, irresponsible, lacking sufficient basic skills, and generally lacking focus on academic achievement. Parents likewise were believed to be unsupportive and of little help in pushing their students to higher achievement in school. Because of this, these science teachers often felt the need to assume additional roles and activities not often included in a traditional notion of teaching. The teachers at Springfield indicated the importance of being supportive, ‘motherly’, and friendly with their students because of the many problems they bring with them to school. Being a teacher meant taking on the additional responsibilities of parenting and counseling that many felt missing from their students’ home environment. In taking on these additional roles, the science teachers expended time and energy dealing with the emotional well being of their students in addition to their academic and mental
needs. This may de-emphasize the academic side of being a teacher as they felt the need to increase the importance of care in their relationship with students.

**Beliefs about Science Content in Science Teaching**

Though the science teachers spoke freely about a number of issues related to science teaching, an area that was given minor importance was science content. Although the participants eventually spoke about science content and its relative importance in teaching science, it received little attention in the construction of their teaching models. Subsequent interviews, however, elucidated a variety of beliefs about science content knowledge in teaching science.

The most shared belief about science content knowledge was that the knowledge held after graduating from college is not really sufficient to teach concepts in-depth. Several pointed out how they have learned a great deal of science since becoming a teacher:

- **Mr. Hibbert:** You can't get around that the first couple of years, because the only way that you're really going to be a great teacher is teaching something over and over again for a few years. And that's how you really learn it….So it's experience-based, very much. (Interview 8/27)

- **Ms. Flanders:** But it’s like anything, if you teach it you learn it a lot better then….But, I think that you learn a lot just through teaching it. So, even though so of the stuff I had years ago, it has come back, and I can read pretty well (laughs). (Interview 9/2)
Others shared similar ideas about how the science content had strengthened and become a bigger aspect of their memory during their teaching careers. Thus, most seemed to recognize that their understanding of science when they graduated from college was not concrete enough to be a good teacher. One has to endure through several years of teaching to better understand the material and how to make sense out of it.

Of the six participants, it was worth noting that Mr. Burns had the most unique response about the importance of science content. Though largely absent from their models, the other teachers all eventually explained the importance of understanding the science content in order to be a quality science teacher. In contrast, Mr. Burns’ omission of science content from his model was consistent with his belief about that area of being a teacher. In his view, any teacher who could read a book would be able to look over the material and understand it well enough to teach it to his or her students. His beliefs showed that one’s personal enjoyment of the material was a more important factor to teaching science. Also worth noting was that of the six participants, Mr. Burns was the only one of two participants without an undergraduate degree in a science content area (Ms. Botz, the other, switched to science education from Pre-Pharmacy and has a great deal of Chemistry content).

A number of reasons exist that might explain this lack of emphasis on the importance of science content in teaching science. One explanation might be that the content aspect of teaching science was likely much more automated compared to other areas of teaching like managing a classroom. For a teacher with 20 years of experience, the cognitive demands of teaching a topic such as the electromagnetic spectrum were likely minimal compared with creating order in the classroom. Thus, these areas of
management and interacting with students made a stronger impact on a teacher’s beliefs about his or job in such an environment. The evidence for this was found in the absence of content-related features in the teachers’ models, although most did later mention the importance of understanding the science that is taught.

Beliefs change over time

Another important finding about the professional beliefs of these science teachers was the fact that many aspects of their belief system, when discussed in retrospect, had changed throughout their career. The models of teaching developed by the teachers provided a current belief profile about their role of teaching. However, subsequent interviews with the teachers revealed how many of the areas of their teaching had changed over the course of their teaching.

One area where this was readily apparent was in the interviews and observations with Mr. Burns. His beliefs about classroom management were strongly confronted during the time of the study due to his unique classes of Physical Science students. There was a tension between the way he wanted his class to be and the actual behavior of his students. It seemed that in previous years his beliefs about classroom management may have been less challenged since he had, based on his descriptions, students who were more mature. As the characteristics of his students changed with the new year, his beliefs about managing them changed, as well. His laissez faire approach to management contributed to a classroom environment that was not very conducive to providing a quality learning experience for his students since they were often out of their seats and talking loudly with one another instead of focused on the tasks at hand.
Additionally, examining both the issues of classroom management and teaching inquiry, it was clear that many of the more experienced teachers had significant shifts in their beliefs about their students. On one side, Mr. Hibbert was unique in thinking that his students were more motivated and concerned about school than they were when he began teaching almost two decades prior, although he does acknowledge that this may have more to do with his own comfort in teaching. Others, such as Ms. Gumble and Ms. Flanders, believe that the students at their school are much less focused on school and had many more problems at home. Getting good grades was less of a concern now. Students now do not have as much maturity as they did in the past and need more help in being able to complete assignments.

In addition to changing beliefs about classroom management and inquiry, further examination of the larger data showed that several of the teachers expressed how their beliefs about instruction had changed during their career. For example, Ms. Gumble mentioned that she was much more personable and easy-going now compared to her first years in the classroom. It was her belief early on that teachers were not supposed to be friendly with their students, although she felt much differently about this now. Others like Mr. Hibbert expressed much more comfort in teaching now compared to early in his career. In his first years of teaching, he indicated that there was an ideal way to teach that one was to achieve over the course of a career. He also tells that experience downplays the importance of planning for instruction since it becomes easier to think about the sequence of instruction from year to year.

Though looking at how these teachers’ beliefs changed over time was not a specific goal of the research, this was an important aspect to add to the conclusions from
the study. Inherent in each of the specific changes above was the idea that increased experience in schools has the power to alter the professional beliefs held by teachers. In areas from beliefs about students to beliefs about how to instruct, experience as a teacher seemed to be a major factor of influence on how teachers understand being a teacher. This observation will be further addressed in the discussion of implications from the research.

How Teachers Define and Describe Professional Beliefs Through Models

The use of models was a somewhat unique methodology in ascertaining the professional beliefs of the participants. Though past studies have used models and concept maps to understand mental processes, the open-ended generation of teaching models used in this study was novel. These models allowed the participants to share their holistic views of being a science teacher with little bias or influence from the researcher. Additionally, they were powerful artifacts in elucidating the relative importance of the various knowledge bases of teachers.

In Defense of Using Models

Despite the various forms of models presented by the participants, the models served as effective vehicles for allowing their thoughts and beliefs about being a teacher to be presented in a visual form. The explanations that followed their drawings helped to explain their design and the parts they included. Since these participants had time to reflect about their profession before completing the task, it was hoped that their models would present their view of teaching as accurately as possible at this particular time of their careers. Additionally, these models could be analyzed by comparing them to theoretical knowledge bases of teachers found in the literature.
Teacher Models and Knowledge Bases

The knowledge bases of teachers have been a subject of debate in educational research. One of the more influential ways of thinking about the knowledge bases of teachers was developed by Shulman (1987). Others ideas have followed, often including aspects of Shulman’s work. These may include a great degree of overlap, with categories of teacher knowledge added, deleted, and/or combined. Barnett and Hodson (2001) presented a more recent example of this as they made a case to support the idea of pedagogical context knowledge. The development of these theoretical ways of thinking about teaching generally share their roots in examining teacher beliefs and practice through observations and interviews. Though each provides a number of teacher knowledge bases, neither provides a measure showing which areas of knowledge are most prominent in a teacher’s beliefs about teaching.

By examining the models developed by the participant teachers with the categories of knowledge given by Shulman (1987) and Barnett and Hodson (2001), it is clear that these experienced science teachers placed much greater emphasis in certain areas compared with others. Of the various knowledge bases from the cited literature these teachers’ models pointed most strongly to areas regarding students and the larger educational context of the school and less so to teacher knowledge concerning science content or specific pedagogy. This may indicate to some extent which of the knowledge bases of these teachers seems to be at the front of their thought processes. Past studies of teacher identity suggests possible reasons for this.

One possibility for a stronger focus on student-related features over content may lie in the educational context of the school. Past research showed how educational
contexts might have an effect upon how teachers view their role in the school (Ben-Peretz et al., 2003). These authors argued that teachers may draw upon the perceived needs of their students for a significant part of their identity. The Springfield teachers worked with many impoverished students and perceived a great deal of need beyond academic areas. Since a large number of these students were perceived as coming from poor backgrounds with unsupportive family structures, the teachers may have felt the need to offer more of themselves in the area of emotional support than in academic support. These teachers still stressed a great deal about the academic side of teaching with their students. This was evident from observations and further interviews when they were prompted to talk about content-related aspects of teaching. However, other facets of being a teacher seemed to dominate their models.

Another study helps explain the relationship between teaching experience and the lack of content-related features. Beijaard et al. (2000) reported that teachers seemed to move from thinking of themselves as a subject matter expert to that of a pedagogical or didactical expert as they gained experience in the classroom. The Springfield teachers had a great deal of experience (with the exception of Mr. Burns at five years), and may have experienced a similar shift as certain aspects of experienced teachers’ knowledge possibly become more implicit over time. For example, after teaching a certain unit in Biology for 18 years, the pedagogical and content aspects of the lesson likely become automatic. In contrast, the methods for motivating and dealing with student behavior are rarely foolproof, requiring teachers to expend a greater amount of mental energy developing knowledge about their students. Perhaps experienced teachers such as those
in this study simply think and reflect more on their interactions with students than about how to present science content.

Subsequent interviews with these participants indicated a number of other issues that likely contribute to their work as a teacher. Some expressed views about how it was important for them to be able to meet and plan specific lesson or units with their colleagues within the science department. Others mentioned how the advent of high-stakes testing over the past few years significantly altered the way they went about teaching their specific science content. However, most of these other areas of teaching were discussed as a response to an interview prompt, differing significantly from the data collection used with the model. The freedom of reflection, with little input bias from the researcher, suggests that these experienced science teachers saw being a science teacher in broad terms that focused more on interacting with students than in conveying content to them. Additionally, non-instructional aspects of the job, such as attending meetings, played a significant role in shaping these teachers’ beliefs about their profession. The emphasis on these areas over content suggests that becoming an experienced teacher involves a great deal more than mastering content knowledge, pedagogical knowledge, and pedagogical content knowledge.

**Beliefs and Practice**

In addition to understanding the professional beliefs held by the participant science teachers, the research also examined the relationship between these beliefs and the professional actions of the teachers. Noting the consistencies and inconsistencies between expressed beliefs and professional practice should provide better understandings about the tensions experienced in the professional lives of teachers. These areas of
inconsistency between belief and practice may prove useful informing reform efforts in secondary science teaching. Additionally, understanding the relationship between belief and practice should help the pre-service teachers in a site-based course comprehend the decisions made by teachers that might be at odds with their novice expectations. For example, the use of a great number of worksheets in class may actually be inconsistent with the teacher’s beliefs about quality science learning. Their use could result from a belief that such materials help students better learn in a way that is consistent with assessments of state testing.

Inconsistencies Between Belief and Practice

Examination of the lack of teaching science as inquiry at Springfield revealed several areas where there was inconsistency between how the teachers believed science should be taught with how it was observed in their classrooms. Most of the teachers in the study valued student-centered learning and placing as much responsibility as possible in the hands of the learner. However, it was rare for students to have a great deal of choice in pursuing their own learning. Though students often worked on a variety of tasks, the teacher almost always dictated the design of such student-centered activities. These science teachers held goals for their students to become more responsible, independent, and better thinkers. Despite these and other similarly desired outcomes, students were not given such opportunities very often.

The chapter focused on inquiry identified a number of factors that interfered with such goals held by the teachers for their students. Among these was the belief that students really do not know how to handle a classroom situation that provides them with greater autonomy. These teachers were pulled in one direction to help students become
more independent, but felt that providing learning situations that could promote that goal would also increase the possibility of chaos, broken materials, and off-task behavior. As a result, the student-centered activities chosen by the teachers were generally ones that are fairly “safe” from a management point of view. Students worked together on handouts and laboratory activities, providing opportunity for them to work with a small degree of independence, although with a thorough amount of boundary provided from the teacher.

Additional factors that constrained the teachers’ beliefs about using more student-centered inquiry learning were the state curriculum, testing, and time. The interviews indicated that these teachers would like for their students to work on in-depth, open-ended assignments and pursue a variety of assessment methods. Working against this set of beliefs was the competing belief that science teachers had a responsibility to prepare their students to successfully complete the state-mandated science testing in the content areas of Biology and Physical Science. Having a limited amount of time to complete a packed curriculum forced instructional choices that stemmed from the belief that the class needed to cover as many topics as possible in the shortest amount of time. Long-term learning opportunities gave way to lecture, worksheets, and quick activities designed to reinforce a particular scientific concept. Additionally, teachers realized that alternative assessment practices, such as portfolios, would likely paint a more accurate picture of their students’ learning. Because of standardized testing practices that emphasized content-focused multiple choice tests, teachers felt that it was in the best interest of their students to use assessment practices that mirror the state assessment.
Other inconsistencies could be found between the beliefs about classroom management held by the teachers and the practices that were observed. As an example, this was most notably observed in the often-chaotic science classes of Mr. Burns. Although he professed a personality that valued a laid-back approach to teaching, it was clear from our interviews that he believed that his classroom should be much more orderly than it was. Other competing beliefs seemed to contribute to his lack of being able to bring the actions of his students back to where he thought they needed to be. First, he expressed that a teacher really cannot conduct class with a style that goes against his or her basic personality. Thus, it was nearly impossible for him to change his laid-back, permissive persona to one that was much more stern. A second belief was that whatever discipline measures he used with his students would ultimately be unsuccessful. Removing students from class or issuing detention did not seem to deter the same behavior in the future, producing somewhat of a sense of helplessness in behavior modification with his students. Because of these competing beliefs, an inconsistency resulted between how he thought students should behave with how he managed the classroom.

Academic and Emotional Support

In previously discussing beliefs through the development of models, it was noted that a prominent aspect of being a science teacher for these participants was in their interactions with students. The perception of students having a great deal of need beyond academic considerations played a part in these teachers feeling the additional need to act as listeners, mothers, friends, and counselors. Observations of these teachers in their classrooms supported a great deal of consistency between this area of practice and belief.
Although they occasionally became frustrated with their students, these science teachers interacted in ways with the pupils to convey a strong sense of warmth and caring.

Ms. Botz, as the bridge to the future for her students, encouraged her kids and kept them on-task in a very non-threatening manner. Ms. Flanders thought that there was a great deal more to being a science teacher than teaching science. She was happy to joke and laugh with her students and listen to them about most any topic when approached. Though Mr. Hibbert’s teaching model was the most strongly focused on student learning, his subsequent interviews revealed his belief that students respond most favorably to a teacher who seems to care about students. As such, he was never observed to raise his voice with any student and provided a great deal of encouragement to his biology class throughout the semester. Ms. Gumble wore her smiling face in her Chemistry class even when she chastised her students for off-task behavior. Despite the chaos often found with Mr. Burns’ class, he cared a great deal about his students and wanted them to be at ease with him and his classroom in hopes that they would trust him and listen to him as a teacher. Lastly, Ms. Quimby often walked through her classroom during student-centered activities, smiling and briefly chatting with them as she offered assistance.

Despite the frustrations occasionally felt by student behavior, the growing demands of their job, or the frustration of preparing students for standardized testing, these teachers were remarkably consistent in practicing the emotional student support of which they included in their models and described in their interviews. Even when disciplining students for off-task behaviors, these teachers generally did so in ways that did not belittle the student or cause embarrassment. For a variety of reasons, it was
important for them to pass on a sense of caring to their students, and this seemed to be the most unwavering area of beliefs for these science teachers.

**Beliefs and Participation in a Site-Based Course**

The last area of research inquiry focused on how participating as a mentor or partner in site-based Methods and Curriculum classes might contribute to science teachers’ thinking about science teaching and learning. Previous partnerships at other schools hinted that working in such a program was beneficial for the in-service teachers just as it was for the pre-service teachers. Examination of the models developed by the teachers, followed by subsequent interviews at the conclusion of the site-based course revealed that these science teachers made small changes as a result of their participation, although none seemed to think of science teacher education as an aspect of being a science teacher.

The most common theme from the participant teachers when reflecting back upon their involvement with the courses placed much more focus on the benefits for the pre-service teachers than for themselves. Several indicated that pre-service teachers need to have as much exposure as possible to authentic classrooms as an adequate preparation. Most echoed the theme that teachers learn to teach by being in the classroom and were supportive of a course design that seemed to maximize their exposure to the realities of a science classroom. The teachers also pointed out how they thought they would have benefited from being able to go through such a course when they were in the process of teacher certification. At the least, being in classrooms early on in the teacher education sequence can help pre-service teachers truly decide whether such a career choice is appropriate for them. For those that stay through for student teaching, the participants
felt that they would be much more prepared for their first year of teaching. Additionally, several noted the importance of the pre-service teachers being able to be at school from the first day of the semester because of the value of getting classes off to a good start.

In terms of their own benefit, the teachers who mentioned any positive returns from their involvement focused mainly on two areas of change in their thinking and practice. The first was the idea of awareness. Several felt that they were being observed more closely and wanted to make sure that the pre-service teachers were seeing good science teaching. In a sense, there was a type of informal reflection about practice occurring with the participant science teachers as they more-often questioned their own reasons for designing and carrying out instruction. A second area that was noted was the impetus to try out new ideas or strategies with their classes. In some cases, the in-service teachers were able to learn a couple of new activities from their partner pre-service teachers as they taught several lessons to the students. In a broader manner, one teacher noted that the goals of teaching by inquiry set forth by the course professors made her more open to designing instruction that was consistent with those ideas.

Those teachers who had hosted previous student teachers and practicum students noted that their role in this arrangement was not very much different from having past students in their classes. Despite the involvement of the science teachers in presenting lessons to the entire group of pre-service teachers, having those individuals in their classrooms seemed peripheral to their job as being a science teacher. Although most expressed a sense of enjoyment in working with their assigned university student, several noted that being involved with the program did not influence them to alter anything they did in the classroom.
From the interviews at the end of the semester it seemed that the biggest influence on these teachers was in affective areas more so than in pedagogy. Several of the participants noted how they appreciated the fact that outsiders (university people) seemed to value their expertise in educating their pre-service teachers. One teacher commented about how being involved with the program allowed for positive publicity for the science department in the local community. Despite the extra responsibilities from being involved with the site-based course, most seemed to support being included in future courses at their school. The early measures taken by the university professors seeking teacher input for the course had positive outcomes in that it built trust with the teachers and provided a sense of professional appreciation as a teacher.

Finally, the models developed by the teachers at the beginning of the semester gave no indication that they included science teacher education as a part of being a teacher. From the data gathered from interviews at the end of the semester, there was no indication that involvement with the site-based course had spawned a development of mentoring or teacher education in their identity. This may not be entirely unexpected since most of these individuals had little previous experience with pre-service education. Only one of the six indicated hosting more than a couple of student teachers during his career. Others, despite many years of teaching, never had a pre-service teacher in his or her class. Even though these teachers helped teach the course through giving presentations and working closely with the pre-service teachers, their views seemed to indicate that assisting with teacher education was something ‘extra’ and not a typical component of being a practicing science teacher.
Implications and Future Research for Science Education

The data and research presented here informs both broad and narrow issues of science education research. Additionally, this study suggests a number of additional questions for future research. The presentation of the data in previous chapters illustrated how research into teacher thinking was useful for examining both the bigger picture of teaching science (through the examination of models) as well as specific aspects of classroom life (teaching inquiry and classroom management). Each of these provided a number of implications for science teacher education and research.

General Issues of Science Education

From a methodological standpoint, the use of teacher-developed models and their explanation served as a useful strategy to make explicit the various ways that teachers identify as a science teacher. Despite the variety of approaches used by the participants in the research, the models that were developed gave a great deal of insight about the needed knowledge bases of science teachers at Springfield. As educational researchers continue to develop theoretical models focused on areas of teacher knowledge, research methodologies coupling a case study approach (Merriam, 1998) with novel data collection strategies like teacher-generated models of teaching provide a degree of insight into the lives of teachers that cannot be matched by less involved methods. Returning to Goodson’s (1981) rationale for understanding about teachers’ lives, “In understanding something so intensely personal as teaching, it is critical that we know about the person the teacher is” (p.69). Case study research as presented here allows for an understanding about the person and identity of the teacher and how that relates to his or her beliefs and actions in the classroom.
Goodson later gives a rationale for studying teachers’ lives as it relates to broader areas of educational research (1992). This type of study can (1) provide a range of insights into moves to restructure and reform schooling; (2) provide information about the importance of experiences prior to pre-service education in shaping the identity of a teacher; and (3) help in understanding issues of gender in teaching. Of these three areas, the research with the Springfield teachers most strongly informs reform and restructuring concerns. The models, interviews, and observations pointed to a number of constraints and frustrations about teaching science in ways consistent with ideas of school reform (AAAS, 1990; NRC, 2000; NSTA, 1995). In the context of this particular high school, the science teachers seemed somewhat overwhelmed at the number of roles and tasks that they had to undertake as a part of their job. Dividing time and attention to non-teaching tasks makes it difficult to invest the resources needed for including higher-level process skills in the science class. Additionally, providing emotional support to their students, who are perceived as having a number of home-related deficiencies, shifts a portion of their science teaching identity away from academic areas to those more concerned with being a caregiver.

Externally mandated “school improvement” initiatives from both the state and federal levels should recognize the constraints and frustrations of teachers as policies are developed. Growing accountability from state departments of education and from President Bush’s 2001 “No Child Left Behind Act” (http://www.nochildleftbehind.gov) remove a degree of autonomy from these science teachers that often gets voiced as frustration. Teachers were compelled to cover content material not because their students find the topics interesting or relevant, but because they have to be tested on it. The
perceived growing paperwork and committee memberships associated with this increased accountability initiative were often mentioned with disdain throughout the study. As state and federal bureaucracy examine the effects of accountability on student achievement and performance, case studies with teachers like those at Springfield begin to shed light on such effects on teachers.

This research reports how practicing science teachers do not include science teacher education as a part of their professional identity. Although the participants voiced their appreciation for being considered an expert and somewhat recognized their contributions to the pre-service education of their partner university students, they viewed their involvement as temporary. The participant teachers seemed to recognize the value to the pre-service teachers in spending greater time in a science classroom. However, their words pointed more to the importance of context than to their own personal expertise and guidance. If science teacher educators desire to have in-service teachers view themselves as agents of new teacher education and induction, perhaps specific goals and strategies for achieving this should be outlined prior to the beginning of the program.

In terms of future research about broad concerns of science education, several research questions arise:

- How does school context shape the professional identity of science teachers?
- How does teaching experience shape the professional identity of science teachers?
How do externally mandated school accountability measures affect teacher retention, stress, and attitudes toward teaching?

**Specific Issues of Science Teaching**

Although looking at the professional beliefs of the Springfield teachers allowed for a holistic understanding of how they viewed teaching, the interviews and in-depth participant observations also provided insights about specific issues of teaching science. Analysis of the data focusing on the themes of classroom management and teaching science as inquiry made explicit the complexities and variables that experienced science teachers encounter in their classrooms. The results from these chapters support and expand upon previous research in these areas.

In examining the classroom management of the three Physical Science teachers in the study, a number of variables were identified that seemed to exert the greatest influence on the varying degrees of classroom order found in each. Differences in the physical classroom environment, the characteristics of the students enrolled, the teacher’s personality, and his or her perceived role each played a part in issues of classroom management. Of these four themes, the differences in student characteristics as a result of ability stratification in the Grade 9 Physical Science classes likely exuded the strongest influence.

When comparing these findings to past research, differences are found in terms of how those are supported by the data from Springfield. For example, Burns (1984) argued a connection between student behavior and the types of learning activities used by the teacher. At Springfield, the types of activities used by the three teachers were quite
similar, although student behavior was quite different. Thus, it did not seem to be the
case that the type of learning activity provided a great deal of influence on the students.
In contrast, this research supports other studies of classroom management that linked
student behavior to the teacher’s actions during the early part of the year (Evertson &
Emmer, 1982). Mr. Burns shared that his management approach at the first of the school
year was inconsistent in terms of holding students to classroom consequences for
inappropriate behavior. The other teachers did not mention the need for significant
changes in dealing with student behavior during the term. This research also supports the
notion that the amount of time students are on task correlates positively with appropriate
behavior (Erickson & Mohatt, 1982). Because Mr. Burns’ class was designed to move at
half the pace of the others, a considerable amount of unintended “downtime” led to ample
opportunity for students to find other ways to outlet their energy. In contrast, students in
the other classes, where time was a more precious resource, moved from activity to
activity with little chance to engage in a great deal of off-task behaviors.

Although a number of teacher-controlled variables have been studied in terms of
how they relate to student behavior, the case studies at Springfield point with equal, or
even stronger, influence to the characteristics of the students in the classes. At one end of
the study, Ms. Flanders’ “gifted” students were eager to do well in their class assignments
and stay out of trouble. In contrast, Mr. Burns’ “at-risk” students largely were quite the
opposite. In reality, a handful of students in each class differed significantly from the
above generalization of the entire class. Nevertheless, the “typical” student in each class
differed significantly. As such, research on classroom management that focused on
students instead of teachers may be of greater assistance in understanding how best to
create order in a classroom. With the Springfield classes as a reference, using students typical of Mr. Burns’ class as informants could provide valuable insight about the variables that contribute to keeping students engaged on academic tasks.

The chapter about teaching science as inquiry was illustrative of how teachers’ beliefs can strongly influence instructional decisions made for their classes. These teachers voiced a number of negative attributes about their students. Although they did not explicitly mean that all of their students held such characteristics, they were prevalent enough to prevent their students from having opportunities to explore science concepts in open-ended ways consistent with reform documents (AAAS, 1990; NRC, 2000; NSTA, 1995). Teachers who fail to recognize students as being responsible and mature seem unlikely to allow greater classroom freedoms.

Echoing the earlier discussion of classroom constraints, state-mandated curricula and high-stakes testing also thwart reform goals in science teaching. Teachers believed that much of the state curriculum is too packed with information and that they need to cover it as quickly and efficiently as possible in order to help their students succeed on high-stakes tests. This latter constraint influenced not only selection of teaching strategies and activities, but assessment as well. Aligning instruction and assessment in ways that are consistent with the state science testing fails to provide ample opportunity for students to learn science as inquiry. Although teachers recognize that such learning is likely to be more enjoyable and meaningful, inquiry learning is largely at odds with other teaching methods that are representative of testing.

The recognition of these constraints should influence science teacher educators and researchers to develop effective ways to introduce inquiry into classrooms where
conditions such as those at Springfield (state curriculum, state-testing, need for improvement of test scores for accountability purposes, etc.) exist. Science teachers working under those constraints partnered with science teacher educators could develop and implement successful small-scale activities that used higher-level inquiry in a way that fit into the cramped science curriculum. As such partnerships showed success in both student achievement and teacher affect, professional development opportunities for science teachers showing the success of such activities could help achieve the goals of reform in science education.

In addition to providing real-life examples of how to include inquiry in typical American science classes, this research also leads to a number of future research questions that could inform both classroom management and teaching science as inquiry:

- What are secondary science students’ perceptions of their teacher’s role (mother, friend, etc.), and how does this perception relate to student classroom behaviors?
- How do students’ perceptions of various behavior consequences (reprimand, in-school suspension, parent conference, etc.) influence classroom behavior?
- How do teachers’ characterization of students relate to choices in instruction?
- How do science teachers change their classroom practices after the implementation of high-stakes testing?
- What types of instructional strategies are used by science teachers who feel the need to prepare students for high-stakes testing compared to those who do not?
Implications for Site-Based Methods and Curriculum Courses

The data gathered in this study supports the use of a site-based design for the education of pre-service teachers. Returning to the goals of the Secondary Science Education Program at the university teaching the course, five strands and six themes exist for their students. The strands are: (1) science teacher with an understanding of the discipline of science and its nature; (2) science teacher as communicator; (3) science teacher as multicultural educator; (4) science teacher as ethical decision maker; and (5) science teacher as a reflective practitioner in school-based experiences. The six themes are: (1) learning; (2) curriculum; (3) planning; (4) conducting instruction; (5) evaluation; and (6) ethics (moral philosophy), values, and beliefs. From a cognitive apprenticeship perspective, working closely with practicing science teachers in an authentic school context should help pre-service teachers better achieve these goals compared to those with more limited secondary classroom exposure. The models, interviews, and observations of the participant teachers particularly support the importance of each of the six themes in becoming a science teacher. From working with the science teachers, the pre-service teachers have a greater opportunity to understand the identity and roles they will likely acquire as they move toward a career as a science teacher.

Additionally, the support for such a pre-service experience was evident from the words of the Springfield science teachers. One of the most common themes through the interviews was the importance of experience in becoming comfortable and effective as a science teacher in the classroom. Because of this belief, the science teachers pointed out how valuable it was for their partner university students to be able to spend the amount of
time in their classes interacting with students and better understanding much of the minutia around working in schools.

Beyond the support, the research recognized how many aspects of the teacher beliefs behind classroom actions are implicit. For example, it might not always be obvious to an observer why a teacher chooses to address a particular behavior in a particular way. The reasons behind instructional decisions are not always clear. One may be left to wonder why a teacher chose to use a particular lab or have confusion about the purposes and goals of specific classroom activities.

As a researcher, many of these questions were answered during the time spent with each of the participants in their interviews. Being privy to their beliefs made a great number of observed classroom actions understandable. For example, Mr. Hibbert might have allowed a talkative student to remain around her peers because he believes that moving her will result in a lowered attention span for the course content. Developing understanding of the professional beliefs of science teachers in a site-based course is useful for both the pre-service teachers enrolled in a course as well as the professors who are teaching it.

For the professors of a site-based course who are turning over a great deal of educational responsibility to the classroom teacher compared to more traditional approaches to pre-service education, realizing that the beliefs of the teacher may differ from their own could influence decisions regarding the design of the course. Pre-service teachers observing these classes would benefit by understanding the rationale behind what might be perceived as questionable actions by the teacher. Some beliefs from the science teachers at Springfield, for example, suggested a lack of value for university
Additionally, the practicality of teaching through inquiry was questioned, clearly at odds with the goals of the courses for pre-service teachers. Though these beliefs may not be consistent across all of the partner science teachers, some of the pre-service teachers in the program may nonetheless be caught in an ideological tug of war between the university faculty and the school science teacher. These tensions of ‘idealism’ versus ‘realism’ may be problematic for the pre-service teacher, but could possibly be alleviated by digging deeper into the professional beliefs of their partner science teacher.

Students enrolled in a site-base course could reflect on such tensions through journals as they wrote about their own struggles in balancing their enthusiasm and idealism with the constraints found in the partner classrooms. Additionally, assignments where the pre-service teacher was able to interview his or her partner teachers about classroom choices and decisions (management, the use of particular strategies, etc.) would make more clear the reasons behind observed actions. For example, through an assignment such as this, the pre-service teacher may understand that a teacher allows a certain behavior with a student because the teacher knows of a personal situation with that student. Decisions on classroom activity may be explained through the influence of preparing students for high-stakes testing. Such interview sessions would help the experienced teachers be able to explicitly share aspects of their professional knowledge base (Shulman, 1987) with the pre-service teachers, as well.

Although logistical considerations in a site-based course may work against it, this research would support pre-service teachers being exposed to the beliefs and actions of more than one teacher. Despite many of the similarities in professional beliefs across the
six teachers, there was uniqueness to each in terms of interacting with students. Since most of the teachers were also focused on one content area or grade level, being able to observe a variety of classes could increase the exposure to the diversity of students at the school. If pre-service teachers could not work out their schedules to observe several different teachers, each could videotape examples of their partner teacher in the classroom and show it to the larger group, for example, as part of a session on classroom management. Each pre-service teacher might show a 10-15 minute segment of the science teacher in the classroom. By showing all the different science teachers at the school, the pre-service teachers would be exposed to a variety of classroom situations through the medium of video. This would be similar to the use of video cases with pre-service teachers (e.g., Cennamo, Abell, George, & Chung, 1996), except in this case the pre-service teacher would lead the case to his or her peers.

Lastly, a stronger collaboration between the university faculty and the secondary science teachers may lead to a site-based course being more influential in the professional development of practicing teachers. As previously mentioned, solving practical issues of reform, such as the lack of inquiry instruction in secondary schools, could be a goal of a site-based course as professors and science teachers continue to build trust through their work in the schools. Since this partnership was new to the science teachers, perhaps it is not surprising that they do not view themselves as a significant part in developing new teachers. Involving these same teachers in future site-based courses may allow greater opportunity for them to develop a “science teacher educator” aspect as a part of their professional identity. If such a goal exists among the designers of site-based courses, then developing specific methods of achieving those goals should follow. For example,
the in-service teachers would receive professional development credit for completing their own assignments related to mentoring the pre-service students. These assignments might include the production of reflective journals and other projects that would heighten their awareness of their role in the course. Future research questions involving a site-based course could include the following:

- How do the professional knowledge bases of pre-service teachers completing a site-based Secondary Science Methods and Curriculum course compare with those in a traditional course?
- How do pre-service science teachers in a site-based course develop and change a model of teaching during their pre-service education?
- How do the classroom management experiences of student teaching compare between students completing a site-based versus a traditional Secondary Science Methods and Curriculum sequence?
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APPENDIX A

A MODEL OF TEACHING

Please develop a diagrammatic “model of teaching”. This model should represent your holistic thoughts about the role of teaching and being a teacher. You may choose to use boxes with words or phrases in them, connecting terms, arrows, circles, etc. Additionally, you may, for example, want to include terms like “curriculum” and “planning” among others. There is no real right way to accomplish this task and it may take a little time in thinking to be able to do this. I apologize for being vague, but I do not want to influence your decisions too much in constructing this. The purpose of this is to get an idea from a practicing teacher as to what all goes into being a teacher and how those things might be related to one another. Having you do this on your own time prevents me from biasing your model with my own ideas about teaching, as I have already developed my own model. You may draw this out by hand or use a word processor. We will use this model as a significant source for our interviews.
APPENDIX B

INITIAL INTERVIEW PROTOCOL

1. Background and Teaching History
   a. How did you come to be a science teacher?
   b. How do you feel about being a science teacher?
   c. Describe your teaching.

2. Early Teaching (try to elicit narrative)
   a. How is your teaching different (if it is) now compared to when you began?

3. Model of teaching
   a. Let teacher explain model and question parts of it.

4. Phrases on cards
   a. How does ______ relate to you being a science teacher:
      (1) managing a lab session
      (2) organizing classroom materials
      (3) knowledge of your students
      (4) knowledge of diverse learners
      (5) professional development
      (6) assessment
      (7) teaching strategies
      (8) knowledge of the science curriculum
      (9) peer (other teacher) interaction
      (10) short-term planning
      (11) long-term planning
      (12) science content knowledge
      (13) knowledge of how students learn/educational psychology
      (14) using technology
      (15) outside policies beyond your control
      (16) establishing expectations, procedures, & routines

5. Others (if they have not been addressed)
   a. Tell me about your classroom management.
   b. How do you deal with ‘problem’ students?
   c. What do you want your students to get out of your science class?
   d. Describe your ideal way to teach.
   e. Explain the thought processes that you would use if you were teaching atomic theory in your class. Why would you choose to do it that way?
APPENDIX C
EXAMPLES OF FIELD NOTES

These field notes are from two different observations in the Chemistry class of Ms. Gumble. (Note – “Ss” refers to students; “T” refers to teacher; “R” refers to researcher; “INT” refers to interruption; “ST” refers to pre-service teacher; “FS” refers to female student)

Date: 8.28.02
Observation #1 Gumble (60 minutes)

Chemistry class

11:35 Ss return from lunch and have a lab to begin (T has gone over lab procedure and other pre-lab stuff before the lunch break).

   Class quiet – T gives directions again about the lab that Ss are about to work on. “Do not contaminate chemicals.” T tells about crossing the chemicals by using the same spatula for different chemicals. She emphasizes that each chemical should have its own spatula. T continues by telling the class where the various lab materials are located in the lab.

   T deals with a little bit of student talking by pausing her speech until its quiet again.

   T continues going over directions. There does not seem to be enough of all the materials so the groups need to share some of the materials. There should be one lab sheet for each group. “Let’s go”

11:37 Ss move to the lab room. This class setup is more like many older schools where the chemical lab space is in a room separate from the classroom. Ss move through the storage space between the 2 rooms into the lab room.

   Ss in lab, putting on goggle, aprons. T (aside to R) says that the students have points taken off of their final lab grade if they are not wearing their safety goggles and other equipment when engages in their lab work, although they can have opportunities to make up any points that they lose.

   T : “You don’t have to wait to get going.”

   S: “Ms. Gumble, where do we put our stuff?” T “ Where do your instructions tell you to put them?”
S: “(Another S) doesn’t have her goggles on.” T “I’ll get her later.” (T was entering attendance into the computer system and not watching the class at that moment.

Ss asking questions about what to do – T still answers by telling them that all of the information is in the instructions and that they need to figure it out.

11:42 (T is not avoiding being helpful, but seems more like she wants the students to take responsibility for their own actions and get used to checking their written instructions before asking the T for help.)

INT – M adult knocks on door and needs something from T.

Ss moving around room getting materials to begin the lab.

(Lab is to investigate qualitatively some properties of chloride compounds on a micro-level)

T seems to put a lot of responsibility on the Ss to answer questions about materials/procedures.

S “We’re missing the top of the micro-wells.” T “You don’t need it.”

11:45 T talking to S about materials.

T checking on S at front of the room in using materials.

S “What about ??? being wet?” T “It’s OK”

T “I’ve got spatulas up here if anybody needs one.”

T directs S about the directions/procedure.

S “(To T) We just have the top to this (microplate)…” Finds out very quickly that another S in his group has the bottom part.

T goes to side of lab to check on some materials.

T notices that some materials have not been picked up, “If you got a strip of pH paper you need the container to compare the colors.” Couple Ss go get the containers.

Ss in front of room putting the chemicals in their microplates. Small line has formed, but Ss wait their turn patiently.

All Ss have their lab glasses on.
S is looking for some material – T tries to help S locate it in the lab.

11:51 S “Should we get our own bottle of ammonia?” T “Share with the other group at the table.”

S “Is this OK?” T – “That’s fine.”

One group is using test tubes instead of microplates to do the lab. T tells them that they need to look at the directions on the lab sheet. Ss get rid of chemicals and start over.

Ss working on the lab procedure

11:55 T & S talk about pH measurements.

S “Are any of these bases?” T “You should test the pH paper with your ammonia to make sure the paper is OK.”

S & T talking about interpreting the pH of the results by using the standard paper that comes with the pH paper. T helps to explain and interpret.

12:03 Ss look at their results in the front of the room. T “Very good.”

S “Where do we get rid of these?” T explains where various waste should go.

S “Ms. F__, how do you call what this reaction is?” T says to just write down a description what was observed.

T “Can you imagine if you used a large amount?” Ss “yeah – why can’t we?”

S “Is it going to hurt to use this (plastic dropper has some clear liquid in it)?” T “When in doubt just throw it away and get another one.” T explains that the mother of one of her students works at a government lab that gets kits with these droppers. The group uses different pipettes so she gets all of the other one donated to her.

12:10 Ss working very independently on lab. All groups seem to be on task. Groups that are finished and finishing are cleaning up their lab areas and equipment as needed.

T knows lots of the Ss very well, both from living in the community for a long time and because she has a child that is the same age as most of these Ss.

S “Where do we dump these?”
T “What are you doing?” One S evidently is being creative with the chemicals after his group has completed their assigned lab. T “Be careful not to get that on your hands.” Some of the MS seem to be curious to see what types of reactions would happen if they were to use larger amounts.

S shows T results and talks about how “neat” it was.

Couple Ss have returned to the classroom and are sitting and talking.

T explains some of what’s going on with the experiment.

Ss talking about using more of the materials to get a more energetic reaction. T says that’s why they’re doing this on a micro level because the reactions would be too vigorous otherwise.

12:15 Ss persuade T to let them use a test tube to mix a greater amount of chemicals. This new mixture causes a more energetic reaction. S runs through classroom holding the test tube and goes toward the trash can. T says not to dump in the trash. S puts tube in a lab sink because it is getting hot and the reactant is expanding over the top of the tube. T moves over to the situation, gets a flask, and puts the tube in it. She later gets another S to move the flask and tube under the ventilation hood.

Most groups are finished, with a few still cleaning up. Other Ss have returned to the classroom.

12:20 Ss sitting in class talking after lab is finished.

12:22 T checks that Ss have washed their hands.

Ss work on completing their lab sheets and turn them in when finished.

Some Ss ask questions about lab sheet – other Ss working on them in small groups.

Ss turn in sheet in a tray on T desk.

One S has questions about protons, neutrons, and electrons.

12:26 All Ss now back in classroom – a few are working on their assignment, others are just chatting.

T goes back to lab room to get some stuff to check student work and student questions to turn in.
12:30 T puts homework assignment on the board and tells Ss that they should begin working on it

Most Ss don’t start on work, so T says that they are wasting their time. More Ss begin working on assignment.

Several MS doing something off-task near window to outside of room. T finally sees this and tells them to move away from the window.

12:35 Class ends

Gumble Obs6 (66 minutes)
Date 10.18.02

10:45 T asks class to sit down. Bell yet to ring. T calls out one S in particular – he points out that there are about 8 other people standing up and he’s the one that gets called. T says that it is because she usually has to tell him twice. Bell rings – T tells that S to sit again. Most of the class is seated. 2 Ss are talking to the T at the front of the room. T “Questions? Questions of the general good?” Nobody seems to have any. MS asks for the T to go over an equation that they had worked on. T says that the Drama Dept. did a really good job last night and that the folks should see it if they have a chance. T points out those in class that were involved.

10:48 T calls on MS to tell her the problem that he wants her to work out. He calls it out and she writes it up on the board. The says that all they will get is the reactants and they will have to work it out. “If you see this you should instantly think…?” Double displacement. T shows how the products will come out. S has question about using subscripts and the coefficient in front of the compounds. Another S asks how they are to know if it is copper 2 – T says that it is because they were given the reactants and you can tell by the coefficients. Next question about how you can tell whether something in the reaction is water soluble. T refers to a chart/table that you have that helps them be able to identify it.

10:51 S asks why the individual parts of the compounds switch. T explains that they ionize they get loose from one another – then 2 will combine and settle out. Another question about why they do what they do – no real answer other than its just in their nature. T lets ST give his explanation…

10:54 T moves on to write on the board the equation that shows all of the component parts on the equation. Lots of Ss are paying attention and involved in trying to understand what is going on (possibly because they have a quiz today?). T continues writing stuff up on the board and explains the use of arrows to show whether a product is a solid or a gas.
10:57  Coach sticks his head in and tells T that her son hit a homerun in whiffle ball today. T erases the board where she had worked the problem out. A couple of Ss ask some last minute questions about the quiz. T gets the pieces of paper ready for the quiz. ST hands out the quizzes while the T shhs them. T tells one MS to move back to the front of the room (the kid she gets on to all of the time). T hands out a second sheet to the Ss that is a chart that they are to use on the quiz.

10:59  Most of the Ss have their quizzes and periodic tables at their desks now. Ss begin on the quiz – one asks about the date. T makes sure that everyone has all of the sheets that they need for the quiz. S asks questions about the numbering on his quiz – T says that there are 4 different quizzes being used and the she numbered them differently from one another so that she wouldn’t make mistakes in grading them. Class is quiet as they all get to work.

11:02  Ss are using a poster on the side of the room as a reference. I can hear loud talking in the room next door – there are spaces between the dividing walls that allow sound through. A couple of Ss come up to the front of the class to ask questions about part of the quiz…T says that she has made a mistake in the problem.

11:04  Ss go up to the T’s desk where she is seated. One turns in the quiz while a couple of others are asking questions about it. The first lunch has let out and there is a lot of noise in the hallway as the Ss go to class. Occasional Ss return to the desk as they turn in their quizzes or ask questions about things. T is talking a little with the ST in the class – think she is getting him to grade to quizzes that have been turned in. About half of the class is finished with the quiz and the rest continue working on it. Most of the folks that are finished are being very quiet as they wait on the class to end so they can go to lunch.

11:09  Bell rings to go to lunch. Some Ss are not finished with the quiz and stay at their desks until they get done. (Lunch break)

11:35  Back in class…T mentions their lab activity that they are going to do. T writes on the board…Ss are sitting and chatting about stuff. T writes reaction up…shhs the Ss to get them quiet. “There is an indirect proportional relationship between the amount of talking you guys do – talking goes up and grades go down…” T calls on MS to interpret what needs to be done with the equation that she has written. He doesn’t really know how to do it, but they realize that they need to add more to it. S says that he would understand it better if he had paid better attention.

11:39  S has a question about breaking up the polyatomic ions on the board that she wrote down…T goes to door and out into the hall to talk with someone that came to the door. Class gets fairly loud as she is absent from the room.

11:40  T comes back in “Now what do I do?” Class calls things out quite loudly and she write their response. S asks about being able to re-take the quiz from before class
– another S asks about the problem that is on the board. T writes another problem on the board and asks MS to work it out. He gets it right – then they go onto balancing it and determining what the precipitates will be. They list out all of the charges that go with the problem. MS is preoccupied with a fly that happens to be buzzing around him. T finishes up the problem by showing which ones react to form the precipitate.

11:45  T starts talking about the lab and that they are not going to have the pre-lab discussion. She tells them where they can find the directions. T allows ST to go over the pre-lab directions. ST gives the directions and the T stands at her desk as they go over it. The class moves to the lab room to do their lab. T stays in the room for a few minutes returning papers and chatting with Ss that have some questions.

11:48  T realizes that she has some other handouts to return to the Ss.

11:50  Ss are in the lab getting the materials out and getting their goggles/aprons on. FS comes to the front of the class to ask for a rubber band to pull her hair back.

11:51  Ss are going to the front of the room to get the materials they need. S asks a question about whether the tube he has is a certain dimension. T tells him that there is a ruler at the side of the room if he wants to find out. S comes and asks T about wearing gloves and things when using acids.

11:53  S asks about what an evaporating dish is. T tells him that things that are not in their desk are on the side table. Another S asks about where to find one. T tells him to ask the S that just asked her. He perfectly quotes her. “Materials that are not in your lab drawer can be found at the table.”

11:55  FS breaks nail in class – another says that she can help because she is in health occupations class. T goes over the lab table to help one group with something according to their procedure. They didn’t ask what to do – it was more of a question about how to set something up.

11:57  Ss are using Bunsen burners – one realizes that his watch glass heats up very quickly. All of the Ss have their lab glasses and aprons on. T “your instructions about the balances refer to the old ones” they use digital ones now. S asks T to help out with the burner.

11:59  Most of the Ss have their burners going at this point. S asks question about the riders (T just went over that with the whole class, but he didn’t hear it.) She explains again to him about how to do that with the digital balance. T explains to S (after he is putting his hands under cool water because he picked up the hot watch glass) that the balance doesn’t make an accurate reading when the glass is hot.
12:01  T keeps an aloe plant in the lab that she breaks a piece off of and puts some of it on the burned kid’s hand. Ss keep working on the lab and T has to correct a few things – S cooling off his crucible by wetting it (now he has to dry it again).

12:07  Ss still working on it – T chats with S about the play that they were in the night before. Another S asks about what to write on the lab sheet.

12:10  S calls on ST for help…Lot of the Ss are waiting on their stuff to cool down so that they can carry on with the lab. Ss are still chatting with the T about their one act play. Everyone seems to be on task with their lab at various points.

12:15  Another S asks about the “rider” part of the directions. T says she needs to change those.

Ss continue with the lab. End
APPENDIX D

EXIT INTERVIEW QUESTIONS

General Questions (for all teachers):
1. Tell me your thoughts about the methods and curriculum class that was here.
2. What, if any, affect has this class had on how you teach or think of teaching?
3. Tell me about the experience of working with the student(s).
4. Do you feel like your participation makes you feel more valued in your contribution to teacher education?
5. Tell me your thoughts about participating in this research.

Ms. Gumble Questions:
1. You sometimes have kids talking while you’re going over things with them. Do you tend to put up with more from some kids than others?
2. Most of the kids seem very involved with what goes on in class. How do grades motivate this group?
3. You mention several times about taking notes/writing things down. Have they improved on doing this?
4. Teaching spdf levels…how much has your past experience contributed to how you teach this and the analogies you use (hotels/rooms)?
5. Talk to me about using videos in your class.
6. You do not have a set routine or assignment at the beginning of class like some of the other teachers. How do you go about getting the class going at the beginning?
7. How do you assess whether everyone was the class really understands a concept when you are going over it?

Mr. Hibbert Questions
1. Tell me about using the QOD (Question of the Day) and the process of checking their work.
2. How much are you able to use grades as a motivation?
3. Why do you give notes the way you do?
4. How do you deal with students that continuously make silly comments (Example from class observation 9:41-9:58A.M.)?
5. Tell me about allowing students to sit where they do. Have you considered moving some of the students in the back corner from one another? How do their grades compare to the others in the class?
6. (10:02) Quote – Talk about trying to get the class quiet using that approach. (The example is of the class talking and he told them they were better people.)
7. You were about to start a bingo thing – you had a girl and you made it a point to loudly tell the class that she got a good answer – why did you make that point?
8. Why do you use games as often as you do? (questions @ 9:33 there)
9. Situation @ 9:45: (Student who had done the wrong assignment) Was that a student-specific decision?
10. Why use the type of organizer that you did (9:47)?
Ms. Botz Questions:
1. Tell me about the use of the class starter.
2. When do you allow students to talk and when do you ask them to be quiet (1:03…)?
3. How do you decide whether all of the students understand a concept when you go over it as a large group?
4. Seems like the size of the class has changed as I have come in. Talk about that.
5. Tell me about the amount of structure you put into a lab activity.
6. Sometimes you sit at your desk; others you walk around. Why?
7. Are the students pretty good at following lab directions (1:45)?
8. The class went to do their lab and they had another sheet to work on – you never said anything but they started working on it anyway when they finished. Do they just know what to do?
9. I thought that it seemed more permissible that students had their heads down at the end of the semester than at the beginning – do you find yourself allowing more in terms of that near the end of the term, especially with those that aren’t doing well in the class?
10. (Situation of balancing equations – students having problems) Explain your decision making process where you abandon this as an individual activity and go to a large group.
11. What are your safety rules in lab – when do you decide they need protection?

Ms. Quimby Questions:
1. Why do you move around the room as the students work on assignments?
2. How does a conversation like 1:16 feel? (Situation described – student says that class is boring). When a student says something about a class like that how does it make you feel?
3. Talk about situation @ 1:23 & 1:48. (Describe B getting back posters and disagreeing with grades). Talk about the dynamics with B and all of that.
4. Why do you allow students to sometimes have their heads down when you review? (Go to next)
5. Talk about the amount of participation in the class. Seems like only a small group readily volunteer information.
6. Why use a Venn Diagram?
7. Talk about using worksheets. Seems like students stay involved when they are doing them.
8. Why do the windmill activity?
9. You referred to the day as ‘get serious Thursday’. Are the students usually less-inclined to complete their work?
10. 1:57 How do respond to Student questions they might have with a worksheet?
Mr. Burns Questions:
1. What is the purpose of the starters in your class?
2. Why do you walk through the class when they are supposed to be working?
3. Talk about issues of not having books/pencils.
4. Talk about how you decide to let Students work when they’re doing activities (10:58).
5. The class seems to have about half of the kids that work on things as they are assigned and another half that don’t. How does the fact that some kids never seem to get on task contribute to how you deal with them? Do you give up on any of them? Do you think they are capable of passing and/or learning?
6. How many times have you kicked kids out this year? You ‘threaten’ the students a lot, but I’ve never really seen you do anything more. Do they find the threats hollow?
7. What about the education of the students who are trying while other students are goofing off a lot? (11:25)
8. (Next) Have you changed your approach to discipline with the class over the semester?
9. How do you think being sarcastic (insulting) with the kids affects the relationship you have with them? (10:58)
10. You often praise students when they do as they are asked, especially with their assignments. Talk about that.

Ms. Flanders Questions:
1. I went through some observations – tell me about why you use a class starter at the beginning of every class.
2. Since that class didn’t seem to make too many demands on you, were you able to use that class a little to prep?
3. How much could you use grades as a motivation in that class?
4. Talk about how you introduce those things and get the kids ready to move around the class
5. I noticed occasionally that the class conversation would digress sometimes. Talk to me about that.
6. One guy questioned a grade he had. Talk to me about how you deal with that.
7. Talk to me about your purposes of using handouts?
8. What level of noise and talk is acceptable to you?
9. Can you look at a group and decide whether they are talking on-task or not?
10. Another time you will go over things as a large group – how do you know when all of the kids are getting it?
11. When the kids worked on their labs together what kind of process did you use to have them in groups?
APPENDIX E
CODING OF DATA

What follows are examples of the interview coding from the data of Mr. Burns. A portion of the complete interview transcript is provided, with the phrases in parentheses coded by the word(s) following in all capital letters. In actuality this occurred using printed copies, highlighters, and pens.

Interviewer: Do you feel any additional stress between having (1) a group of kids that are a little rougher this year, and (2) a political push for more accountability and those types of things?

Burns: (I’m hoping that when they come and see how my kids are doing and relate that back to my accountability, they’re going to keep in mind the group of kids that I have. I’m not too worried about that) TESTING, STUDENT CHARACTERISTICS – if they want to come down here and fire me, come down here and fire me. (I’m not too worried about that. The stress that I get is from just trying to get across something to the people that want to learn when you have 20 other people that don’t want to learn. That’s the stress. I’m not too worried about accountability at this point.) TEACHING, FRUSTRATION

Int: This is a little different for you because the other people have taught for a longer time, but how is your teaching different now than it was your first year teaching, if it is?

B: (My teaching is probably not a whole lot different. The first year, when you don’t know any of the material. I think what I did outside of the classroom, preplanning, during your planning period, at home – that’s the stuff that really changes a lot.) TEACHING, CHANGE Now, you tweak it; (I have definitely learned a lot each year, but it’s probably little stuff; content-related stuff, time management stuff, how long labs take, how long it takes to grade stuff. I’ve just kind of refined what’s going on, but as far as the amount of time I spend lecturing or doing general activities, that generally has stayed about the same.) EXPERIENCE, TEACHING

Int: Just mainly the amount of time outside of blocks 1-4?

B: Exactly. (I have learned how to maximize whatever spare time I have so you don’t have to take a lot of work home, don’t have to grade a lot of papers there, set up for one class and use it 2 days later for something else. That has helped a lot. First year teachers spend entirely too much time working on that kind of stuff because they’re just not good at it yet. But most of them can teach pretty well.) TEACHING, EXPERIENCE

Int: So you had a different style?
B: Yeah, I had a different style. And (your first year you kind of develop that style, but after a year or two you should kind of develop who you are, and if you try to be someone else you will probably put a lot of extra stress on yourself. You can make your style work – so figure out what you like and what you are good at and make that work.) TEACHING, MANAGEMENT, PERSONALITY

Int: Is it also fair to say that you’re having to adjust your style some this year – not necessarily adjust your style but to adjust some things?

B: Definitely, yeah, (if I came in here and I tried to be extremely strict – everybody’s going to sit down- I can’t do it. I don’t, I can’t do it. So, yes I am going to modify it on the needs of the class, but I am still me and that my classroom is going to be a little more laid back.) MANAGEMENT, PERSONALITY The next box under that is to tailor your discipline plan to different classes. That’s kind of what we were talking about. (It’s still my style but you’re going to have classes that need seating charts and classes that don’t need seating charts. It’s important to be flexible, and you don’t have to treat everybody exactly the same and every class exactly the same. So, be flexible and tailor your discipline accordingly.) MANAGEMENT

Int: Do you find the 10th graders a lot easier to deal with than 9th graders?

B: (They are more mature and the big difference is that you don’t have all of the, everybody that is in the 10th grade biology class passed physical science with a passing grade, so they have; not that they are good students, but you don’t have the real bottom of the barrel people who are here just to get out of the house. So, you knock out the bottom 25% of the people who give you problems, for the most part. It’s a big difference between the 9th and 10th grade. I found biology much easier and more enjoyable to teach.) STUDENT CHARACTERISTICS, TEACHING The last one under classroom management is to (be consistent and to follow through. Everybody starts out the year with rules and regulations that would be just find, but if the kids start pushing you and seeing what they can get away with, you’ve got to be consistent and follow through with your rules. I’ve learned that the hard way this year. I went through about a month or so where I didn’t follow through with my consequences and now I’m going to have to turn over a new leaf and pick up some of those new rules again, and it’s helping out a lot.) EXPERIENCE, MANAGEMENT
From these sets of codes, a large data table was developed where all such instances of each code were placed together with a corresponding identifier showing the line number from the interview transcript. A portion of the one used for Mr. Burns’ data is presented below:

| Teaching | • The workload here, I think, has been pretty average compared to what it would be at another school. The administration has been helpful here – I don’t think we’ve had any real big butting head problems with the principals or assistant principals. (42-44)
• I have a relaxed, and sometimes too relaxed atmosphere in the classroom. That’s my personality. That allows me to have a lot of fun. If you have a good class, it’s great. If you have a bad class, and this year I’ve got some rough classes that have really pushed me, and I’ve had to start over again and get more and more strict. But, in general my disposition in my classroom is kind of easy-going and relaxed and louder than in most other classrooms and I’m comfortable with that. (61-5)
• I do enjoy this subject, which helps. The labs and activities, I really think a lot of that is interesting to me, and I think that helps. Every once in a while you can get people to pay attention enough to realize that what we are doing is kind of cool and interesting, and they like it, as well. (65-8)
• Teaching has been good for me. I enjoy being able to…the hours are good, for one thing – I’ve got family at home, so that’s important. But, besides putting up with your classroom management stuff, teaching in general is a pretty stable, non-stressful environment – it’s pretty secure. If you were out in sales, or trying to work on a quota or something, you would have other types of stress, so that’s pretty nice. (68-73)
• I’m hoping that when they come and see how my kids are doing and relate that back to my accountability, they’re going to keep in mind the group of kids that I have. I’m not too worried about that (78-80)
• The stress that I get is from just trying to get across something to the people that want to learn when you have 20 other people that don’t want to learn. That’s the stress, I’m not too worried about accountability at this point. (81-3)
• The first year, when you don’t know any of the material… I think what I did outside of the classroom, preplanning, during your planning period, at home – that’s the stuff that really changes a lot. (88-90) |
I have learned how to maximize whatever spare time I have so you don’t have to take a lot of work home, don’t have to grade a lot of papers there, set up for one class and use it 2 days later for something else. That has helped a lot. First year teachers spend entirely too much time working on that kind of stuff because they’re just not good at it yet. But most of them can teach pretty well. (98-102)

Your first year you kind of develop that style, but after a year or two you should kind of develop who you are, and if you try to be someone else you will probably put a lot of extra stress on yourself. You can make your style work – so figure out what you like and what you are good at and make that work. (138-41)

They are more mature and the big difference is that you don’t have all of the…everybody that is in the 10th grade biology class passed physical science with a passing grade, so they have…not that they are good students, but you don’t have the real bottom of the barrel people who are here just to get out of the house. So, you knock out the bottom 25% of the people who give you problems, for the most part. It’s a big difference between the 9th and 10th grade. I found biology much easier and more enjoyable to teach. (157-62)

The textbooks that we have are pretty good, but in order to make it as relevant as possible it is nice to get out and talk to other teachers, get on the internet, check out some other resources that are going to hopefully bring it home for you a little more than what they give you in the book. (174-7)

Supporting the kids in whatever they’re doing, whether it’s the debate team or whatever. I would enjoy doing that and showing that support to them. So that’s a big part – it takes up tons of weekends and afternoons and stuff, so that’s a big part of a teacher’s life, or it should be, if they can. (194-7)

Below that…keeping up with meetings, obligations, and duties….We have SST’s, we have break duty, we have morning duty. We have obligations to work as ticket collectors at games. We’ve got…you know, we’ve got a ton of stuff. You’ve got to have a calendar and keep up with it. All that stuff outside the classroom is big enough that it needs to be an important skill and is important to your teaching formula- teaching plan. (197-202)

A lot of stuff goes on outside of the class during breaks, at lunch, after school…where these relationships built outside mean a lot and help you a lot in the classroom. Be a good listener (218-20)
• a really great technique to help the relationship is to share stories about when I was a teenager or things that I am going through now to show them how similar we were or how similar we are, and I think that is beneficial in those relationships. Spend time talking to and doing what they like was a box under that. (224-7)

• Comment on the role of you being a young teacher and relating to them. I know it doesn’t make me a better teacher, I know that. In fact, it might make me a worse teacher because my teaching is not as refined, but I am confident that I relate better to the kids because of it.

• the relationships make my job more fun, for one thing. I enjoy relationships with the teenagers. So, that’s a benefit for me, hopefully the benefit for them is that if they think I’m cool or whatever you want to call it, they will hopefully listen to me in class when I’m trying to teach, or they will respect what I say or my opinion or when I say something is important. I think kind of being buddies with them helps. And a lot of teachers don’t have that. (248-53)

• I have definitely learned a lot each year, but it’s probably little stuff; content-related stuff, time management stuff, how long labs take, how long it takes to grade stuff. I’ve just kind of refined what’s going on, but as far as the amount of time I spend lecturing or doing general activities, that generally has stayed about the same.

• At the beginning of the year they weren’t working the way I wanted them to and they knew that and they were in the routine of doing their type of thing, and now we’re kind of compromising a little bit and are in a different routine. It’s important, and they can be flexible- you can kind of change that and modify it. (260-4)

• I don’t feel like the outside board policies make a big deal to what’s going on in the classroom. (272-3)

• We try to do a lot of different learning activities related to the same topic, so hopefully they can pick it up in one or two different methods depending on how they learn. The labs…always offer 1 or 2 labs directly related to the topic that we’re studying so that it works well to compliment whatever lecture or worksheets we are doing. (468-72)

• One on one for 10 minutes is worth an hour and a half with 30 students in there. (474-5)

• I’m not in any way set in my teaching method. I’m always looking for ways to improve my teaching method. As my time frees up at home I will probably change some of my teaching habits, as well. I’ll do more things that allow me
to spend more time grading this or assessing that, or building outside experiments or models…do more stuff. (573-7)

- I think most teachers, myself included, are kind of, at least in science, are QCC objective-driven. We’ve got a million and one objectives and they’re all layed out and you have X amount of time and you’ve got to get them all in. They’re very specific. The textbook that we use does a decent job of following that. So…I’d say that a lot of the way I teach is curriculum driven, not necessarily the way I teach, but what I teach and why I’m teaching it. I cover stuff that needs to be covered. I might spend more time in things that I am personally interested in, but atomic theory is something that’s got to be covered. So, open up the book and see what’s required and make sure we cover all of it. (584-93)

- I’ve taught plenty of physical science classes, but this is the first that has been grouped homogeneously like this. By far, the most difficult classes I’ve taught. (657-9)

- A lot of these kids…all of my kids, my classes are singled out – I have them because they are in the bottom 25% based on their ITBS scores. So, most of my kids are in the same pot and learn in similar ways, I would think. I can’t get up and lecture for 30 or 40 minutes. I can’t tell them to go home and read a chapter and outline it. So, it has definitely affected the way I try to teach. (699-704)

- at this level the content that we’re teaching is very basic. If somebody from the math department or the English department went home and looked over a few pages the night before, they could come in and know everything that they needed to know. So, my science content knowledge hasn’t done a whole lot to aid the students or benefit the students. Your interest level, and English or a math person might not really care or enjoy it. I think that’s more important than…I mean, anybody could get up there and talk about what the book says. The books are extremely basic. (726-32)

- The concept is to try to get them going without a whole lot of direction so I can take roll or get organized or take care of people coming in late or whatever, and they can know what is going on. I’m not really great at enforcing that. Other teachers, when the bell rings they are supposed to be seated with their notebooks out working on it and not speaking for the first 5 minutes. The kids that I’m working with after 3 or 4 months will still come in and won’t open anything, won’t get anything out until I tell them 5 times. I
<table>
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<th>Student Characteristics</th>
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<td>• No place is going to be perfect when you have the demographics we have here, when the housing projects are right across from the school that make up 50% of your student population. The family structure that those kids are coming out of is pretty bad and you see a lot of that in your classroom. With that said, there are a ton of really nice kids who are enjoyable to be with. (36-40)</td>
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<td>• This age group is a lot of stress, but it’s a lot of fun. They’re old enough that you can play with them and pick on them and do things with them that you couldn’t do in middle school. (40-42)</td>
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<td>• I’m hoping that when they come and see how my kids are doing and relate that back to my accountability, they’re going to keep in mind the group of kids that I have. I’m not too worried about that (78-80)</td>
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<td>• They are more mature and the big difference is that you don’t have all of the…everybody that is in the 10th grade biology class passed physical science with a passing grade, so they have…not that they are good students, but you don’t have the real bottom of the barrel people who are here just to get out of the house. So, you knock out the bottom 25% of the people who give you problems, for the most part. It’s a big difference between the 9th and 10th grade. I found biology much easier and more enjoyable to teach. (157-62)</td>
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<td>• high school students constantly have problems, boy problems, girl problems, home problems. And if you listen to them, it does a lot to build that relationship. It builds trust, and hopefully you can turn that around in the classroom if you have some of these students and they will be more willing to listen to you. (220-23)</td>
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<td>• I think I have a lot of things in common with a lot of these kids, and that has made a huge difference. They’re always into sports, and I would play basketball with them every period during my planning period over in the gym. I really got to know them in a totally different setting on the basketball court pushing them around as opposed to in a classroom. (227-31)</td>
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<td>• I would love to use them and there is no way that I would think the idea is good but these kids, for the most part, need an enormous amount of pushing to get them to do something. (57-65)</td>
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<td>• I’ll let everybody else just hang out to dry there if one of my good students actually has a question. (175-6)</td>
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- I will let everybody else just hang out to dry there if one of my good students actually has a question.
ever bring that into my classroom, which is very unfortunate. These kids break and can’t even handle the most basic and indestructible lab equipment that we have (interruption). We have kids that like to steal and like to break, and do not have respect for equipment. They would dump a drink over on a laptop and immediately try to hide it instead of stepping forward and admitting it. (285-90)

- at least my students this year are not really mature enough to know when to switch on their brains and when to switch them off, and when to pay attention and when not to. (443-45)

- So, as far as learners go, they don’t, and I have all of those kids. (467-8)

- every problem student is a different problem student. So, whatever I say…you can try to take bits and pieces and try, and there will be some general fundamentals that will form a framework for dealing with these kids. It’s different – some of them I kick them out immediately, I just can’t deal with it. Others, they really don’t grate on my nerves that much, and I kind of give them a lot of flexibility and let then do stuff around the classroom instead of trying to get them to work. I let some kids stand in the hallway for the entire period just because they don’t want to be in the classroom. I don’t have a problem with that. Some of them you can talk to parents, some of them don’t have parents, so that won’t work. (521-31)

- I don’t particularly care if they get much of my subject matter. It would be nice, since they have to pass to go to the next grade and get out of high school. But, I would be much happier if they just kind of learned, on an academic level, some study skills. Some of these kids have slow reading abilities and understanding what it means to actually go home and study. (539-43)

- the kids that I had last year was a totally different group of kids and they would come in with a lot…both of them. They come in with a lot of study skills and a lot of respect that these kids don’t have right now. (552-5)

- so many other people they want to talk to, so much other fighting and talking that they really can’t…they’re not really able to see that this would be enjoyable or that they might like it. (561-4)

- I have 6 students passing out of 65; they’re going to have problems with the textbook and everything in it. (601-2)

- The classes that are the worst usually have the most dynamic people, students in them, which means that you
have the potential to have the most fun in those classes. You’ve got students that are so animated that you love them and they’re the same kids you throw out of your class three times a week. That class almost kills me some days. It’s just so big and just requires 100% constant monitoring. You can’t…but there are a lot of fun people in there, as well. (639-45)

- There might be one or two people in there that are passing. A good 80% of them have no idea of what is going on – grades in the 20s or 30s, and are constantly asking me, “Did my grade come up? I did my worksheet today.” They just have no clue. Several of those kids are just waiting to drop out. It’s a difficult environment when you have that many kids and half of them are this and half of them are that…don’t care, can’t read, just there to cause trouble, just there to sleep because they don’t want to be at home. (645-52)

- Most of those kids are all right on the internet. You’ll have a handful of kids that can’t, still. We can’t walk down the hallway without my kids acting like fools, so even that, I feel if I can get in here, stay in the classroom, and kind of contain them that I feel more comfortable. (682-5)

- I wish that I had students I felt were responsible enough to use a $2000 laptop. (691-2)

- A lot of these kids…all of my kids, my classes are singled out – I have them because they are in the bottom 25% based on their ITBS scores. So, most of my kids are in the same pot and learn in similar ways, I would think. I can’t get up and lecture for 30 or 40 minutes. I can’t tell them to go home and read a chapter and outline it. So, it has definitely affected the way I try to teach. (699-704)

- I made a bet last period with a student that if she made a ‘B’ in the class I would shave my legs. I’ve made bets to shave my head…I’ve made bets for money – I’ll give you $100 if you pass a test. Coming at it totally different, just try to scare them into showing them how difficult their life is going to be if they drop out of high school. So, as far as motivating them, I don’t know what works. I think different things work for different students, but I’m definitely trying different stuff with different students. (709-15)

- The kids that I’m working with after 3 or 4 months will still come in and won’t open anything, won’t get anything out until I tell them 5 times. (61-63)

- Those kids come in the door with a smile on their face already trying to jaw on me. Yes, it’s disruptive sometimes,
but I would rather have those kids be kind of, not friends because I know they’re not friends, but have a positive outlook on me. They’re not going to pass anyway, so I would rather be buddies with them than have them hate me and have them disrupting my class all day. (210-14)

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<td>The colleagues here are great, extremely helpful. I think everybody here helps out whenever somebody else needs it and that’s been real nice, as well. (44-6)</td>
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<td>The textbooks that we have are pretty good, but in order to make it as relevant as possible it is nice to get out and talk to other teachers, get on the internet, check out some other resources that are going to hopefully bring it home for you a little more than what they give you in the book. (174-7)</td>
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<td>The moral support has been big—especially the first year, second year. Just comforting was really nice. Now that I am more comfortable, it is good for stress relief. We bounce some ideas off of each other, but for the most part I have taught this a thousand times, and I’ll add some little stuff each year that kind of pops up, but I’m really not out pounding the pavement looking for new ways to reinvent, you know, the course or the curriculum. So, the peer interaction is probably a little more laid back and social, and sort of non-professional at this point. (779-85)</td>
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<td>When I shared a classroom, when I floated, I did it a lot, and I had a planning period that would be in someone else’s classroom, so you interacted with them a lot. Now I am sort of tucked away down here so I don’t do that as much. My first couple of years I floated in between 2 other science teachers and we did a lot of that—a ton of that, and that was good. (789-93)</td>
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<td>I have a relaxed, and sometimes too relaxed atmosphere in the classroom. That’s my personality. That allows me to have a lot of fun. If you have a good class, it’s great. If you have a bad class, and this year I’ve got some rough classes that have really pushed me, and I’ve had to start over again and get more and more strict. But, in general my disposition in my classroom is kind of easy-going and relaxed and louder than in most other classrooms and I’m comfortable with that. (61-5)</td>
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<td>Classroom management…. The first thing that I have is to develop your own style and don’t try to be someone else.(123-4)</td>
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<td>your first year you kind of develop that style, but after a year or two you should kind of develop who you are, and if</td>
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you try to be someone else you will probably put a lot of extra stress on yourself. You can make your style work – so figure out what you like and what you are good at and make that work. (138-41)

- if I came in here and I tried to be extremely strict – everybody’s going to sit down- I can’t do it. I don’t, I can’t do it. So, yes I am going to modify it on the needs of the class, but I am still me and that my classroom is going to be a little more laid back. (146-8)

- It’s still my style but you’re going to have classes that need seating charts and classes that don’t need seating charts. It’s important to be flexible, and you don’t have to treat everybody exactly the same and every class exactly the same. So, be flexible and tailor your discipline accordingly. (150-3)

- be consistent and to follow through. Everybody starts out the year with rules and regulations that would be just find, but if the kids start pushing you and seeing what they can get away with, you’ve gotta be consistent and follow through with your rules. I’ve learned that the hard way this year. I went through about a month or so where I didn’t follow through with my consequences and now I’m going to have to turn over a new leaf and pick up some of those new rules again, and it’s helping out a lot. (162-8)

- stay in your chair unless you have permission, no horseplay…just standard stuff, rules that you would want to have an orderly classroom. (172-3)

- The last thing under student-teacher relationships is that you can be a teacher and a friend at the same time. I want to have stuff in common with them and want to share my stories to show that I am similar to them, but you just have to find the line where you’re still doing your job and you’re still putting a priority on helping them pass your class and helping them get out of school as opposed to helping them have a good time. (235-40)

- The younger and more immature the student, the more direction, guidance, and lack of flexibility I am going to give them. Safety is important and is a key rule in regards to how it’s managed. I will let some kids play around with the stuff even thought they’re not following the directions of the lab if they are doing it in a safe manner. I would rather have them interested than just sitting down sleeping or something. Labs are going to be a little more noisy than other types of activities. I usually don’t have a problem with that as long as it’s not too out of control. (419-26)

- Managing your classroom when they’re all in chairs is very
different than managing when you’ve got 30 of them up, wandering around and you’ve got fires all over the place. (432-4)

• I’ve got enormous amounts of talking going on this year at these little tables. Other than that, they can get up and sharpen their pencils and get what they need at their own will. (445-7)

• every problem student is a different problem student. So, whatever I say…you can try to take bits and pieces and try, and there will be some general fundamentals that will form a framework for dealing with these kids. It’s different – some of them I kick them out immediately, I just can’t deal with it. Others, they really don’t grate on my nerves that much, and I kind of give them a lot of flexibility and let then do stuff around the classroom instead of trying to get them to work. I let some kids stand in the hallway for the entire period just because they don’t want to be in the classroom. I don’t have a problem with that. Some of them you can talk to parents, some of them don’t have parents, so that won’t work. (521-31)

• The classes that are the worst usually have the most dynamic people, students in them, which means that you have the potential to have the most fun in those classes. You’ve got students that are so animated that you love them and they’re the same kids you throw out of your class three times a week. That class almost kills me some days. It’s just so big and just requires 100% constant monitoring. You can’t…but there are a lot of fun people in there, as well. (639-45)

• I’ve tried moving kids around in different seating charts, but there’s so many people in there I can move a kid to 5 different tables and he would have somebody to talk to just as loud as where I moved him from. I don’t have enough room to spread them out. I told a kid yesterday, get up and go move over there so you will stop yelling across the room. (671-6)

• Most of those kids are all right on the internet. You’ll have a handful of kids that can’t, still. We can’t walk down the hallway without my kids acting like fools, so even that, I feel if I can get in here, stay in the classroom, and kind of contain them that I feel more comfortable. (682-5)

• I wish that I had students I felt were responsible enough to use a $2000 laptop. (691-2)

• INT: Once you’ve got them working you often walk through the class and monitor the students. Explain to me your purposes of doing so.
Mostly its crowd control. If you don’t do that they will get off track in a matter of 30 seconds. At those tables, the way that classroom is set up, your going to have an entire table off track and it requires constant monitoring to do your best to keep them focused on their work or they choose not to, or whatever. (78-84)

- Most of the books are already gone, so as far as getting them to bring them class, it’s a moot point – they don’t have one. Pencils and pens, I’m pretty lenient. I could give them lunch detention if they didn’t bring them to class, but I don’t want 85 students per day in lunch detention. Its easier for me to say go get one. A lot of teachers would probably say that you need to teach them the responsibility of it, but at this point that seems to be more of a headache for me and I have plenty of headaches already. (92-8)

- They complain so much about working with students that I place them with, that a lot of the time I do let them choose their own partner, and I just try to keep them focused the best I can. If I had enough equipment I would prefer to have them work by themselves. I don’t have that much equipment and it would also be twice as much or more grading as opposed to grading a paper with a couple of names on it. So that’s another reason why I practically that I do like group work. But they’re hard – sometimes the labs they just see it as free time to go do whatever. (103-9)

- Some teachers don’t let kids sleep, wouldn’t dream of letting kids get on the computer – both of those things I let them do because so many of my kids will absolutely do nothing and if they can find something to do quietly, I’ll let them do that. I can’t – not that I can’t motivate them – but they’re not really being motivated. I can’t kick them out; ISD would be full every single day with 10 or 12 of my students. So, I just try to include them in some fun activities. We try to do several – 1 or 2 things – a day that are engaging. Hopefully, just get them in, get their brains tuned in and get them focused for a little bit and try to use that to keep them going and keep them on track, use some of that focused-ness on the worksheet or on the problems. (128-37)

- They don’t really – I’m not going to say that they really don’t want the kids down there, they want to support us by having a place we can send those kids, but they would not be happy if I sent all of my bad kids out whenever I needed to, whenever I was following up on everyone of my threats. My class would be empty. So, I definitely limit that
until I’ve had enough by the end of the day or the end of
the period. I’ve made 10 threats and finally somebody gets
busted. I’ve had enough and somebody finally gets busted.
It’s not really a big threat to them anyway. It’s more just
for me to have them out so I can somewhat move on. They
don’t really care, most of them don’t. A lot my kids would
like to be somewhere else besides my classroom. (150-9)
I have always been a relaxed teacher. This year that has –
not that they take advantage of me – they just don’t really
do anything. So, my discipline did get more strict. It’s now
kind of slumped off again, but its so much work to monitor
that over the course of a day or week it just slides off. I
think that next semester I might try to start off on a strict
kick. From a grade’s point of view I don’t see it doing
anything. I’m tired of people coming in there and playing
games while I’m teaching – it’s rude – However, if I say,
and I’m debating no more computer, those kids are not
going to pass anyway. What good is it doing? Probably
none. It’s going to make them probably mad at me, so I
don’t know. I’m still fiddling with my policies. (191-200)

• The stress that I get is from just trying to get across
something to the people that want to learn when you have
20 other people that don’t want to learn. That’s the stress,
I’m not too worried about accountability at this point. (81-
3)
• I don’t think you do until you get here. No, you don’t
realize how much stuff you have to do outside of…you are
constantly asked to help out with this committee or that
committee. (212-13)
• we’ve got new textbooks this year, which has kind of
thrown me for a loop (458-9)
• I’ve tried moving kids around in different seating charts,
but there’s so many people in there I can move a kid to 5
different tables and he would have somebody to talk to just
as loud as where I moved him from. I don’t have enough
room to spread them out. I told a kid yesterday, get up and
go move over there so you will stop yelling across the
room. (671-6)
• If I had enough equipment I would prefer to have them
work by themselves. I don’t have that much equipment
and it would also be twice as much or more grading as
opposed to grading a paper with a couple of names on it.
So that’s another reason why I practically that I do like
group work. (105-8)
• it’s been extremely frustrating having a classroom full of kids like that. (127)
• When you have a class of 18 and 15 of them are clowns, there’s not a whole lot you can do, unfortunately. I want to offer those kids any of my time after school, before school, whatever extra help they might need. If they have questions I will most definitely try to cater my time to them. (167-70)

Change
• The first year, when you don’t know any of the material… I think what I did outside of the classroom, preplanning, during your planning period, at home – that’s the stuff that really changes a lot. (88-90)

Experience
• I have definitely learned a lot each year, but it’s probably little stuff…content-related stuff, time management stuff, how long labs take, how long it takes to grade stuff. I’ve just kind of refined what’s going on, but as far as the amount of time I spend lecturing or doing general activities, that generally has stayed about the same. (90-94)
• I have learned how to maximize whatever spare time I have so you don’t have to take a lot of work home, don’t have to grade a lot of papers there, set up for one class and use it 2 days later for something else. That has helped a lot. First year teachers spend entirely too much time working on that kind of stuff because they’re just not good at it yet. But most of them can teach pretty well. (98-102)
• be consistent and to follow through. Everybody starts out the year with rules and regulations that would be just fine, but if the kids start pushing you and seeing what they can get away with, you’ve gotta be consistent and follow through with your rules. I’ve learned that the hard way this year. I went through about a month or so where I didn’t follow through with my consequences and now I’m going to have to turn over a new leaf and pick up some of those new rules again, and it’s helping out a lot. (162-8)
• I’m still probably not very good at it, so it’s not something you learn early on. (431-2)

Personality
• your first year you kind of develop that style, but after a year or two you should kind of develop who you are, and if you try to be someone else you will probably put a lot of extra stress on yourself. You can make your style work – so figure out what you like and what you are good at and make that work. (138-41)
• if I came in here and I tried to be extremely strict – everybody’s going to sit down- I can’t do it. I don’t, I cant do it. So, yes I am going to modify it on the needs of the
class, but I am still me and that my classroom is going to be a little more laid back. (146-8)

### Planning

- I have to plan, because we have new textbooks that are all out of order...so, I’m spending a lot more time than I did last year, but the book’s good. The resources are good that come along with it – the transparencies, test generators. I’ve been pretty pleased with the set of materials that come along with it (183-6)

- I do all short-term planning, I don’t do any long term planning at this point. Well, that’s not quite right. When you’re first…my first year it would be too much to plan for a week because you don’t know how the first day is going to go – I don’t know how long this worksheet is going to take, so you can’t plan for the next day. At this point, that’s easier for me now. I’ll plan for tomorrow, I’ll teach tomorrow, see how it goes, see if I have two things that run over, or if I need to go over or repeat something. So, I plan the day before, so most everything that I do is short-term. If I know something is coming up next week or what not, I will do some long-term planning. I will get some articles run or go the library and get a video that I know I am going to need next week, or, I kind of pull stuff and set it aside for when I am going to use it. But other than that I don’t do a whole lot of long-term planning. (751-61)

- I know the topics that are coming up. I mean, I’ve taught it enough sometimes down the road in a few weeks or a month I’ll need this. Or if I see an article that I know relates to one of the topics we cover, I’ll set it aside. But we take about a week or so per chapter and keep a casual pace. I plan one day at a time and don’t do a whole lot of long-term planning. (765-9)

### Other Teachers

- A lot of teachers are involved in that type of stuff in general, whether it’s coaching the cheerleading team or just going to the football games. (191-2)

- I always have half a classroom full of kids that want to talk about stereos, so doing what they do and talking about what they talk about has made a very big affect in my relationships with them. The other teachers who don’t have that…I’m not saying that the other kids don’t have respect for them, but it has helped out. (232-5)

- A lot of teachers would probably say that you need to teach them the responsibility of it, but at this point that seems to be more of a headache for me and I have plenty of headaches already. (96-8)

- I don’t feel a need…they really don’t identify with most
teachers, so it just kind of helps with the attitudes in class. (218-9)

Self
- I think I have a lot of things in common with a lot of these kids, and that has made a huge difference. They’re always into sports, and I would play basketball with them every period during my planning period over in the gym. I really got to know them in a totally different setting on the basketball court pushing them around as opposed to in a classroom. (227-31)
- The last thing under student-teacher relationships is that you can be a teacher and a friend at the same time. I want to have stuff in common with them and want to share my stories to show that I am similar to them, but you just have to find the line where you’re still doing your job and you’re still putting a priority on helping them pass your class and helping them get out of school as opposed to helping them have a good time. (235-40)
- the relationships make my job more fun, for one thing. I enjoy relationships with the teenagers. So, that’s a benefit for me, hopefully the benefit for them is that if they think I’m cool or whatever you want to call it, they will hopefully listen to me in class when I’m trying to teach, or they will respect what I say or my opinion or when I say something is important. I think kind of being buddies with them helps. And a lot of teachers don’t have that. (248-53)

Testing
- I don’t think that I would teach any different if they got rid of it. (281)

Space
- We have fixed tables that are fixed to the floor, with 3 or 4 students per table, so I don’t have a whole lot of freedom in how I organize that. I thought it was great for biology but I think it’s horrible for physical science. You have half of the classroom with their back facing you. (439-42)
- I’ve tried moving kids around in different seating charts, but there’s so many people in there I can move a kid to 5 different tables and he would have somebody to talk to just as loud as where I moved him from. I don’t have enough room to spread them out. I told a kid yesterday, get up and go move over there so you will stop yelling across the room. (671-6)

Organization
- I try not to take anything home, so I very rarely lose something. I just kind of keep it all there in one area in a couple of folders, one for each class and…It’s important to have a couple of filing cabinets where you can organize tests, worksheets, all my notebooks with different materials in it. (451-4)
| Assessment | • I know I need to make my assessments, for a lack of a better word, a little bit different than they are. I still use the scantron test as one of my major objective assessments. I refuse to grade 70 short-answer tests. (502-5)  
• we’re kind of throwing all of that out the window and doing kind of an individual work contract where they’re not going to take any kind of formal tests at all. They’re just going to generate a test grade by how many points they accumulate by working kind of on their own. Part of that is taking an oral quiz every day. You can really get a good idea of what’s going on up in their head when they have to close all of the books and notebooks and just talk to you. So, I think that’s been helpful to me – the oral aspect. (505-12) |
| Goals | • I don’t particularly care if they get much of my subject matter. It would be nice, since they have to pass to go to the next grade and get out of high school. But, I would be much happier if they just kind of learned, on an academic level, some study skills. Some of these kids have slow reading abilities and understanding what it means to actually go home and study. (539-43)  
• And on a non-academic level, how to behave in a classroom and how to be respectful. Not to say morals, but things that go along with that, to me, are just as important here at this level in these kids’ lives as the academic aspects. (544-7) |
<p>| Gender | • I think your male students interact with you differently and your female students do, as well. We could pick at this forever and kind of come up with a lot of different stuff. I think it’s probably been good thing (interruption). You hear the students picking on, or trampling on different teachers when they come in and seems that they do that equally with males and females alike, so I don’t think my job is any easier, but…working out with them in the weight room and pushing them around on the basketball court, the fact that I might be bigger or stronger than a lot of my male students helps. (614-22) |
| Motivation | • I made a bet last period with a student that if she made a ‘B’ in the class I would shave my legs. I’ve made bets to shave my head…I’ve made bets for money – I’ll give you $100 if you pass a test. Coming at it totally different, just try to scare them into showing them how difficult their life is going to be if they drop out of high school. So, as far as motivating them, I don’t know what works. I think different things work for different students, but I’m definitely trying different stuff with different students. |</p>
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<td>• They are not motivated in any way by grades. (69)</td>
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<td>• It would be really nice if all of my kids were motivated by grades like they would be in a private school. When I went to school you just did what you needed to do and I think that I have 1 or 2 students, if I’m lucky, in each class that are actually trying a little bit to pass. (73-6)</td>
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