

ALTERNATIVELY CERTIFIED MATHEMATICS TEACHERS: FACTORS THAT
CONTRIBUTE TO CHANGES IN INSTRUCTION OVER TIME

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Doctor of Philosophy

by

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The undersigned, appointed by the dean of the Graduate School, have examined the dissertation entitled

ALTERNATIVELY CERTIFIED MATHEMATICS TEACHERS: FACTORS
THAT CONTRIBUTE TO CHANGES IN INSTRUCTION OVER TIME

presented by Ryan Andrew Nivens,
a candidate for the degree of doctor of philosophy,
and hereby certify that, in their opinion, it is worthy of acceptance.

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ABSTRACT

The focus of this study was the intersection of alternative certification for mathematics teaching, standard's based teaching as described by the National Council of Teachers of Mathematics, and the No Child Left Behind Act that permitted alternatively certified teachers to be "highly qualified." Zeichner and Schulte (2001) stated, "the evidence about the teaching competence of alternatively certified teachers that is based on classroom observation is very weak" (p. 277). This study strengthens that gap.

This study investigated the instructional practices of 25 alternatively certified mathematics teachers in the state of Missouri over three years. Using qualitative methods, observation and interview data were analyzed to reveal the primary mode of instruction used in the classrooms and analyzed the changes in instructional practices over time. Vignettes of teachers were created to illustrate the instructional practices, and case study teachers were chosen to document the changes over time and reveal associated factors.

Six distinct instructional practices emerged from the data. The analysis of the changes over time revealed four types of teachers, with 14 of the 25 in the category *Unchanging*. Of those using a variety of practices, the factors of content-specific professional development and certification program support seemed to hold the largest influence on teacher growth in instructional repertoire.

The findings of this study imply that certification programs should focus on educating their participants on the effective use of a range of instructional practices and should focus on support structures for teachers in the classrooms. Furthermore, building principals should support teachers with mathematics-specific professional development, especially for small rural schools.

CHAPTER 1

Introduction

Teacher preparation programs serve the primary purpose of developing the instructional practices of teachers. Over the past 25 years, three events have impacted the educational landscape, particularly in the area of mathematics teacher preparation. First, in the early 1980s, alternative certification for teacher licensure was implemented to address a shortage of teachers in various subject areas, including mathematics (Darling-Hammond, 1990; Dill, 1996). Later in the 1980s, a movement to reform mathematics teaching took shape in the form of Standards recommending a change in instructional practices (National Council of Teachers of Mathematics, 1991). More recently, the No Child Left Behind Act of 2001 (NCLB, 2002) requires a “high quality” teacher in every classroom, identifying alternative certification as a viable way to meet this requirement of quality. These policy reforms have placed new demands on teacher preparation programs, while also allowing for these programs a chance to certify non-traditional students. In the following paragraphs, I discuss the three issues above, namely: alternative teacher certification, teacher quality, and instructional practices. The purpose of this discussion is to provide background on why the study described in this dissertation – examining instructional practices of alternatively certified secondary mathematics teachers – is needed.

Alternative Teacher Certification

In this section, I discuss alternative teacher certification as it relates to the policy and teaching issues relevant to my study. I begin with an overview of alternative

certification followed by research studies that inform us on some of the effects of this pathway to teaching.

Alternative teacher certification is one attempt to address the shortage of teachers by providing an expedited route for content area specialists into the field of teaching. The definition of “alternative” has various interpretations, and alternative programs are becoming typical routes for people entering the profession (Boyd et al., 2006; Feistritzer & Chester, 2000). With a shortage of mathematics teachers at the secondary level, many state legislators, including those in Missouri, adopted alternative teacher certification as another pipeline into the teaching profession. Policy makers and educational researchers theorized that individuals with work experience outside the education field would be able to make content meaningful due to these experiences. Researchers such as Shen (1997) have documented positive impacts that alternative certification programs have on teacher education, such as providing more teachers in urban settings and bringing more minorities into the teaching field. These studies have led to the belief that alternative certification can serve as a means to improve teacher quality.

Teacher Quality

Though alternative certification programs have positively impacted the teacher workforce in a number of ways, the increased demand for high quality teachers places new challenges on these programs. With the passage of NCLB, the focus on the quality of classroom teaching has intensified and is now an explicit component of educational policy. NCLB states that alternative certification provides a “high quality” route to teaching. However, a closer look at studies on alternative certification reveals that “the research is ambiguous on how well [alternatively certified] teachers perform and is insufficient to conclude that alternative licensure paves the way for well-educated adults

to enter teaching” (Berry, 2001, p. 34). However, teacher performance is just one definition of teacher quality.

Cicchinelli, Gaddy, Lefkowitz, and Miller (2003) noted that the quality of alternatively certified teachers is uncertain since current laws measure quality by a “degree, a passing score on a subject-matter test, and certification,” and that the impact of these teachers on student achievement is unclear (p. 5). As noted by Cicchinelli et al. “it’s important to recognize that in order to be truly effective, credentialed professionals must draw on the best teaching strategies available” (p. 6). However, while much research on instructional practices has been conducted over the years, few have documented the instructional practices of alternatively certified teachers. This oversight is due in part to the continued debate over what institutions should be involved in the certification of teachers and what outcomes matter (Darling-Hammond, 2002; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Walsh, 2001a, 2001b). Policy makers and directors of alternative certification programs need information on the instructional practices that teachers from these programs employ during their initial years of teaching to better assess the impact of alternative certification programs and their production of quality teachers. In the following section, I further discuss the research on teacher quality from the viewpoint of instructional practices.

Teacher Instructional Practices. The National Council of Teachers of Mathematics (NCTM) details recommendations for best teaching practices. In the *Professional Standards for Teaching*, the NCTM (1991) provided six standards of teaching in four broad aspects of mathematics teaching: designing and implementing worthwhile tasks, facilitating effective classroom discourse, maintaining an effective

learning environment, and analyzing teaching and learning that occurs. Research on teaching practices in these categories includes the careful selection of mathematical tasks (Stein & Lane, 1996) and creating a classroom atmosphere of open and critical dialogue (Lampert, 2001). Furthermore, research on teachers' self-analysis has focused on the use of teacher reflection for improvement and change in teaching practices (Cobb, Boufi, McClain, & Whitenack, 1997; Cooney, Shealy, & Arvold, 1998; Mewborn, 1999).

Furthermore, teacher instructional practices impact student achievement scores and student learning. While the research on which practices are best cannot be proven (Hiebert, 1999, 2003), particular elements of teaching appear to have a positive impact on student learning. Furthermore, researchers have shown that the classroom teacher's role in the classroom is closely linked to student achievement (e.g. Mevarech & Kramarski, 1997; Schoen, Cebulla, Finn, & Fi, 2003; Silver & Stein, 1996). Hiebert and Grouws (2007) summarized the research demonstrating a positive impact on student performance. Studies of teaching practices fell into two categories: the instructional practices that emphasize conceptual understanding and instructional practices that emphasize fluency with skills. Instructional practices that emphasized fluency with skills included a fast pace through the curriculum, more homework, teachers actively involved in teaching, and well-organized teachers. The instructional practices that emphasized conceptual understanding had two primary features: 1) both teachers and students attending to the mathematical concepts to be learned, and 2) classrooms where students struggled with important mathematical concepts. Because of the variety of classrooms, teachers, and students, Hiebert and Grouws do not prescribe any particular style of teaching, but rather

that whatever methods are used that the teacher keep the focus of the lesson on these two primary features. In chapter 2, I elaborate on these studies.

Franke, Kazemi, and Battey (2007) also conceptualized instructional practices as falling into one of two categories: Initiate, Response, Evaluation (IRE), and non-IRE. The IRE instructional practice consists of a “teacher-*initiated* question, student *response*, and teacher *evaluation*” (p. 231). This form of instruction is dominant in U.S. classrooms and it oftentimes called “traditional teaching” in mathematics education research. The non-IRE instructional practice is any type of instruction that is not dominated by the IRE model.

Background Issues

To further situate my study, I describe the relevant background issues concerning teacher shortages, alternative and traditional certification, and the debate over teacher certification. These issues demonstrate the importance of research to examine the instructional practices of alternatively certified teachers.

Traditional certification routes have been unable to meet the demands of the educational needs of the public schools (Dill, 1996). In Missouri, a teacher shortage exists in the area of mathematics, with the state granting an average of 200 middle and/or secondary mathematics teaching certificates each year compared with over 400 middle and secondary mathematics positions open (Reys & Reys, 2004). With the number of undergraduates too small to fill the jobs, legislators look to provide ways to bring other college graduates from related fields into the profession. To facilitate the transition into teaching, in 1989 (and later revised in 2000), Missouri enacted policies to encourage new certification programs that would provide both efficient and expedient certification routes

for individuals from non-traditional teaching backgrounds (Feistritzer & Chester, 2000). The intent was to attract people with related degrees to enter the teaching profession and to provide an expedited pathway into the field (Darling-Hammond, 1990). Many individuals enter alternative certification programs with characteristics that differ greatly from those of traditional program graduates, such as people in their late 20's to early 30's (Stevens & Dial, 1993). Despite the available demographic data, little is known about the individuals enrolled in alternative teacher certification programs (Friedrichsen, Lannin, Volkmann, Arbaugh, & Abell, 2005). To further obfuscate the matter, alternative certification requirements vary from state to state, leading to substantial differences in the design of alternative certification programs by the colleges and universities (Feistritzer & Chester, 2000).

The impact of various routes to certification has been a topic of research and contention (Darling-Hammond, Chung, & Frelow, 2002; Walsh, 2001b). Recent studies (Suh & Fore, 2002) suggest that certification often functions more like a checklist that rarely focuses on teacher learning or on developing professional standards for teaching. To clarify the distinction between traditional and alternative certification, I define traditional and alternative teacher certification as they concern this study.

Traditional teacher certification in the United States consists of college undergraduates enrolling in education courses (Feistritzer & Chester, 2000). Typical courses include foundations of education, adolescent psychology, reading in the content areas, classroom management, psychology of exceptional children, and a methods course in the content area. Instructional internships, or practica, coincide with college classroom coursework, allowing preservice teachers experience in the K-12 classroom environment.

A program typically culminates with a semester of student teaching, in which the undergraduate enters a regular classroom under the supervision of the regular teacher. For secondary education majors, a prospective teacher sometimes earns a bachelor's degree in a specific content area, such as mathematics.

Alternative teacher certification in the United States consists of college graduates enrolling in courses to achieve a teaching certificate. Like traditionally certified teachers, prospective teachers take similar coursework. However, many programs offer these courses over a shorter time span to accelerate the process. While some courses span a matter of weeks over the summer, others take place in evenings during a regular semester or on weekends. Alternative certification programs often differ from traditional programs in that they often do not require internships or practica. Students in these programs are often serving as full-time classroom teachers while completing their coursework for certification – work that is sometimes called “on the job training” (Dai, Sindelar, Denslow, Dewey, & Rosenberg, 2007; Sorensen, Young, & Mandzuk, 2005).

Various perspectives currently exist that influence the design of teacher preparation programs. Zeichner (2003) characterized three voices in the debate over teacher preparation, two of which relate directly to this study. The first is the “professionalization agenda,” spearheaded by the National Council for Accreditation of Teacher Education (NCATE), the National Board for Professional Teaching Standards (NBPTS), the National Commission on Teaching and America's Future (NCTAF) Report, and the Teacher Education Accreditation Council (TEAC). The second is the “deregulation agenda,” proposed by groups such as the Fordham Foundation, the Abell Foundation, the Pacific Research Institute, and the Progressive Policy Institute.

Primary components of the professionalization agenda are identified in *What Matters Most: Teaching for America's Future* (National Commission on Teaching & America's Future, 1996). The authors describe teacher quality as being assured through three components of teacher preparation: accreditation, licensing, and advanced certification (p. 29). However, a gap exists between the initial licensing of a teacher and the process of advanced certification. Furthermore, some teachers pursue avenues not addressed from this view. For example, in Missouri, advanced certification in the form of National Board Certification is not recognized at the state level. Proponents of this agenda encourage states, such as Missouri, to adopt policies requiring advanced certification for teachers, promoting teaching as a profession that requires continued growth and advancement.

The deregulation agenda recommends that barriers to certification be removed. Many researchers (Walsh, 2001a; Walsh & Jacobs, 2007) in this camp suggest that content knowledge is sufficient knowledge for quality teaching. They conclude that unnecessarily restrictive regulations keep many highly qualified, potential teachers out of the profession. They use college professors as their example of how secondary teachers could possess content knowledge and learn the technicalities of teaching while on the job.

Both positions agree on the premise that most teachers currently produced are of low quality. Their difference in viewpoint results in different solutions on how to address the problem. However, not everyone agrees that teacher preparation, whether it is highly regulated or not, is the problem (Ingersoll, 2007). Researchers point to the problems of teacher attrition and the problems of the context teachers find themselves.

Interestingly, neither position cites research demonstrating that teaching is of low quality. Both sides appear to assume that the teacher workforce currently employs poor instructional practices. Along with the increase of teacher shortages, additional challenges exist in filling teaching vacancies concerning quality teaching practices. The NCTM recommends that mathematical understanding be the focus of instruction for all children (NCTM, 2000). Such policy is essential, but leads to challenges due to the shortage of mathematics teachers. One question that arises is: How might quality teachers be developed that can teach all types of children, all cultures of children, and know their content area well? Several individuals have weighed in on the benefits and value of teacher certification, and many of these arguments center on issues of teacher quality (Darling-Hammond et al., 2002; Darling-Hammond & Youngs, 2002). In order to know what educational experiences teachers provide for students, it is imperative that we look inside the classroom (Cooney, 2003; Hiebert et al., 2005; Roth & Garnier, 2007).

Statement of the Problem

While alternative routes to certification widen the pipeline for entry into teaching, little is known about the instructional practices of these individuals. Many teachers that have completed alternative certification programs take jobs in urban and rural areas, addressing shortage areas that are often not met by traditional certification programs (Shen, 1998). Though Zeichner and Schulte (2001) identified studies (Hutton, J. B., Lutz, F.W., & Williamson, J. L., 1990; Lutz, F.W., & Hutton, J. B., 1989; White, K., Stuck, G., Wyne, M., & Coop, W., 1984) where alternatively certified teachers were observed, they question the validity of these observational data. Summarizing the current research, Zeichner and Schulte (2001) state, “the evidence about the teaching competence of

alternatively certified teachers that is based on classroom observation is very weak” (p. 277). We need to better understand the instructional practices of alternatively certified teachers, how they change over time, and what factors influence changes in instructional practices to better guide educational policy and the design of programs for alternatively certified teachers.

Purpose and Research Questions

This study was designed to provide a better understanding of the instructional practices of beginning teachers, in particular, alternatively certified teachers. A further aim of this study is to understand the relationships between teacher characteristics, school and classroom factors, and the instructional practices of alternatively certified secondary mathematics teachers. Such information can inform state level policy makers and university level program directors by guiding the future decisions made regarding the development and implementation of alternative certification programs and the quality of teaching used by graduates of these programs.

This study examined the following questions:

1. What instructional practices do 25 beginning alternatively certified mathematics teachers from eight university programs in one state employ?
2. How do the instructional practices of these teachers change over the first three years of their teaching?
3. What contextual factors may have influenced changes in their instructional practices?

Definitions

For the purposes of this paper, the following terms are defined as follows:

Alternative Teacher Certification – teacher certification that is not part of an undergraduate degree program. Any certified teacher who is a graduate of one of these programs, or a recipient of a teaching license as a result of participation in one of these programs shall be referred to as an “alternatively certified teacher.” This definition is aligned with the definitions offered by other researchers (Feistritzer & Chester, 2000; Zeichner & Schulte, 2001). These programs are typified by expediting teachers into the classroom, and by helping non-traditional students become fully certified.

Traditional Teacher Certification – teacher certification through an undergraduate program at a college or university. This includes four and five-year programs.

Standards-based instructional practices – instructional practices that exhibit best practices as recommended by organizations such as the National Council of Teachers of Mathematics (NCTM, 1991, 2000) and are supported by research findings.

This study focuses on the instructional practices of alternatively certified teachers in their first three years of teaching. In the following paragraphs, I further describe a framework for examining the instructional practices of mathematics teachers.

Teacher instructional practices. This study draws heavily on previous work by Horizon Research in their study of the impact of professional development on teacher instructional practices. In their study, the research team examined the instructional practices of 364 teachers by looking closely at the lesson design, pedagogy, content and classroom culture (Weiss, Pasley, Smith, Banilower, & Heck, 2003). These four dimensions of instructional practices serve as the guiding framework for this study. Drawing on work from the *1999 TIMSS Video Study* (Roth et al., 2006) based on Schwab

(1973), Figure 1 was created as model to represent the relationship among these three dimensions of instructional practice.

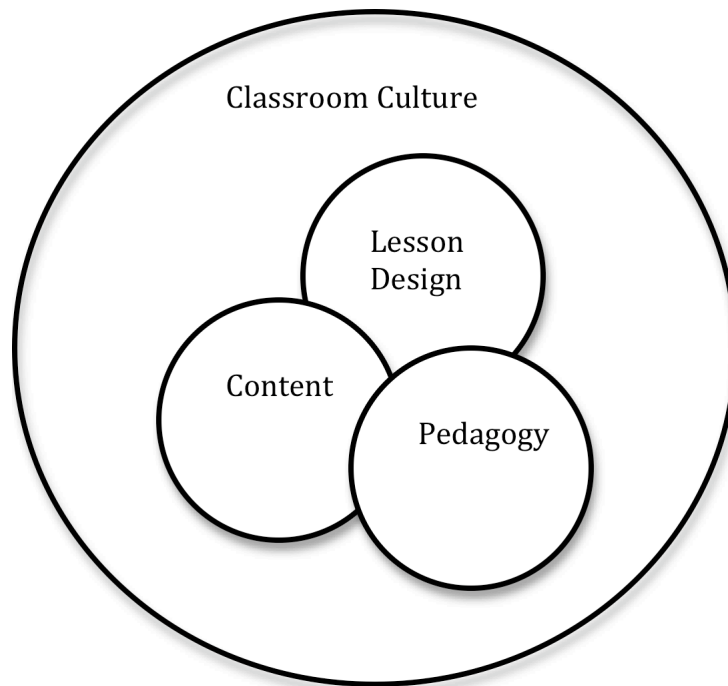


Figure 1. Mathematics Teacher Instructional Practices.

The outermost region of Figure 1 consists of classroom culture. Broadly defined, this represents the classroom norms within the classroom setting that the teacher and the students negotiate. Mathematics education researchers have characterized the norms that create a classroom culture conducive to learning and working with mathematics (Kilpatrick, Swafford, and Findell, 2001; Lampert, 2001). Typically, these norms have included the mathematical discourse used in the presentation of problems, their solution, and the presentation of solutions as part of the cultural aspects of teaching found within different countries (U.S. Department of Education, 2003).

Within the research literature on instructional practices in mathematics education, researchers have described teacher instructional practices in different ways. Franke,

Kazemi, and Battey, (2007) categorized instruction as either traditional or non-traditional. Traditional instruction is typified by a teacher initiating a mathematical process, the students providing a response, and the teacher immediately evaluating that response (IRE) (Cazden, 1986). Traditional teaching is so prevalent that international studies of teaching practices that include the United States have identified this as the primary culture of teaching within this country (Stigler & Hiebert, 1999). Non-traditional teaching practices have long been advocated, but never embraced by a significant number of teachers. These non-traditional practices include a focus on mathematical dialogue, with both the whole class and small groups. In such a classroom, mathematical activity is driven by problem solving and conjecturing. Teachers focus on the processes of problem solving that go beyond just arriving at correct solutions. Because of the discrepancies in instructional practice and advocated practice, Hiebert and Grouws (2007) found that rather than specific recommendations for teaching, they were able to identify instructional practices that researchers had shown to be effective. Two of these practices are a focus on computational fluency and conceptual understanding.

A second aspect of the instructional practices framework, lesson design, consists of the pre-lesson planning a teacher does when considering the prior content knowledge students need, the related experiences students have, and how the lesson ties in to other subject areas. Local, state, and national standards should also play a role in the design of a lesson, as do anticipated misconceptions and student difficulties.

Last, content is the final aspect of instructional practices framework. This includes considerations of the appropriateness of the content for the students in the classroom and how the teacher portrays the content within the classroom. The

appropriateness of the content could be determined by looking at content recommendations such as the Content Standards within the NCTM (2000) *Principles and Standards for School Mathematics* or other district or state curricular documents. In addition, the content should be portrayed as a dynamic body of knowledge, that mathematics involves reasoning and thinking, and that mathematics connects to other areas of mathematics as well as other subjects.

These definitions of pedagogy, content, and lesson design, are all situated within the classroom culture in Figure 1. These served as the focus for the design and the analysis for this study of alternatively certified mathematics teachers' instructional practices, as seen at the base of Figure 1. These two frameworks focused the study as I sought to answer my research questions.

Overview of Dissertation

This chapter provides an overview of the issues relevant to this study. Various situations led to the creation of alternative routes into teaching, particularly within the subject area of mathematics. While consensus within the educational community does not exist about the best way to certify mathematics teachers, research into the practices of teachers who complete various routes to teaching can guide policy and practice. In this study, I address this gap in the research by examining the instructional practices of a group of alternatively certified, secondary mathematics teachers as they progress through the first three years of their teaching career.

In Chapter 2, I provide a review of the literature relevant to this study, including a closer look at some of the aforementioned research. I start with the empirical research on

alternative teacher certification, followed by a review of research of the other factors, namely school context, professional development, knowledge of teaching, and beliefs.

Chapter 3 provides details on the methods used, including details of the participants, instruments used, and data analysis. In Chapter 4, I present the findings of the study. Finally, Chapter 5 concludes with a discussion of the study as well as future avenues for further research. It is my hope that you enjoy reading the next four chapters, as I have found their writing to be engaging and worthwhile.

CHAPTER 2

In this chapter, I describe the extant research literature that guided the design and implementation of my study. I have divided the review of literature into three sections that provide a research basis for the frameworks found in Chapter 1. The first section focuses on the research in alternative certification, which accounts for the “Certification Program” component in Figure 2. I include this section separately from the other two sections for two reasons. First, my research questions are directed toward teachers that entered the profession through alternative routes. As such, any study of teachers from these routes should be thoroughly informed by the research that exists in that realm.

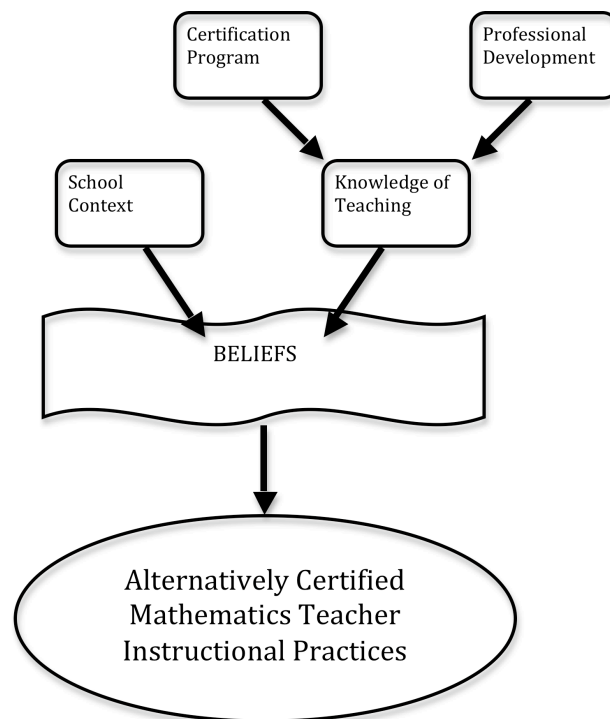


Figure 2. Framework for Studying Factors that Influence Instructional Practices.

Second, a thorough review of alternative certification programs and research provides a rich base of possible factors on which to reflect.

The second section involves an examination of the research of factors that impact a teacher's instructional practices. Specifically, Figure 1 illustrates the influence of the factors associated with instructional practice. These studies delve into aspects of alternatively certified teachers and I have divided them into the three remaining components: the school contexts they find themselves in, the professional development in which they engage, and their knowledge of teaching. I conclude this section with research concerning teacher beliefs. Everything a teacher learns or experiences is filtered by their beliefs, and while this study is not focused on those beliefs explicitly, some discussion of this topic is merited.

The final section details the mathematics education literature on teachers' instructional practices. Figure 2 details the areas of classroom observation that describe mathematics teaching. The first is the instructional style employed, referred to as pedagogy. The second is the focus of the instruction on content, regardless of the teaching style. The third, lesson design, involves an examination of how the teacher accounts for the previous knowledge and experiences of the students and how the lesson connects to other areas of mathematics and other subjects. Finally, culture describes the culture of the classroom environment, and how intrapersonal relationships enhance or hinder the mathematical development and learning opportunities for the students. I begin by first looking at the research that has been conducted in alternative certification.

Research on Alternative Certification

U.S. policy related to alternative certification for teachers began in the early 1980s and spread through most states. As this study deals directly with teachers in alternative certification programs, I sought to imbed my research questions in the current literature on alternative certification. Various researchers (e.g., Darling-Hammond, 2002; Walsh, 2001a) have argued for or against offering alternative routes to teaching. However, this review only considers empirical studies that examined various aspects of alternative certification programs.

The findings on alternative certification fall into five broad categories: (a) research on various alternative certification programs, (b) descriptions of alternative certification including recruitment and retention of alternative certification teachers, (c) perception of support, mentoring, and preparation, and (d) professional identity/efficacy studies. In the following sections, I review the research literature in each of these categories.

Research on Various Alternative Certification Programs

This sub-section describes the research that examined different types of alternative certification programs. Concerning this dissertation, these studies provide a look at what alternative certification programs look like and what they do for the teaching profession. In these studies, we see how diverse the alternative certification programs are as well as the various ways researchers evaluated their effectiveness and value.

Broyles (1992) described an alternative certification program for secondary teachers that became the state's model for secondary teacher preparation. The Teachers for Secondary Schools Program (TSSP) at the University of Southern Maine required applicants to meet the general standards of a 2.5 GPA and a 900 GRE score. Following this gateway, applicants were interviewed to determine their commitment to teaching. In addition, an essay is required to determine the writing skills of the applicant. From the applicant pool, they selected 20-25 applicants to form a cohort for the academic year. During the program, the "interns" visited the classroom of a teacher every Wednesday. They observed several other areas, such as special education classes and vice principals' offices. They shadowed a student for one day of class followed by an interview. After these experiences, the interns completed a 14-week student teaching assignment. The accepted applicants reflected a full spectrum of people, ranging from forester to doctor. The average age of the interns was 32. The program partnered with five local high schools. A high level of participation of the high school faculty existed in the planning and teaching of the teacher education courses. The TSSP program exceeded state minimum requirements. Each course was infused with interdisciplinary aspects as well as a focus on problem solving and connection making. Job entry rates of intern graduates ranged from 75 to 100% over the first 6 years of the TSSP. The number of applications to the program increased 87% during the previous four years.

Cohen-Vogel and Smith (2007) tested the following assumptions that alternative certification programs are able to: attract people from outside of

education to teaching, improve the quality of teacher candidates, fill positions in hard-to-staff schools, and help alleviate out-of-field teaching. They used the Schools and Staffing Survey (SASS) data from 1999-2000 that represented 9605 teachers that had been hired for their first year of teaching between 1995-96 and 1999-00. Of these, 6728 had a regular certificate obtained through a traditional route. There were 1201 teachers who were alternatively certified or provisionally certified while in process of obtaining alternative certification. The first year teachers (those hired in 1999-00) consisted of 2215 teachers, with 1326 with regular certification and 273 with alternative certification. The authors found that only 36% of alternative certification teachers were enrolled in college the year prior to teaching, compared with 57% of traditionally certified teachers, a statistically significant difference. Alternative certification teachers were twice as likely to enter teaching from a nonteaching job in education. However, of the alternative certification teachers, 50% majored in education. Alternatively certified teachers were 12 times more likely to have no practice teaching than traditionally certified teachers. For 1999-2000, there were no statistically significant differences in teachers working in urban, high-poverty, or high-minority schools. Concerning the alleviation of out-of-field assignments, no significant differences in the percent of alternatively and traditionally certified teachers teaching one, two, three, or more classes outside of their major. The authors concluded that the assumptions of alternative certification filling hard-to-staff schools and alleviating out-of-field teaching are unfounded.

Masci and Stotko (2006) evaluated the ProMAT program by measuring satisfaction with various components in the program and by reporting the candidates' Praxis II Pedagogy scores. Of 132 participants, 100 completed and returned their survey (76% response rate). In addition, the researchers examined 123 Praxis scores of the program participants (representing 93% of the ProMAT population). They analyzed the surveys along nine domains: selection procedures, additional training and/or orientation, course instructors, course content, field experience placements, summer school internship placement, full-year teaching fellow assignment, program orientation, and supervisory support. Other survey areas included: overall rating of the program and whether they would recommend the program to others. Within the survey data, the following means were found (each category was on a 10-point scale, with 10 being the highest rating):

- selection procedures, 8.6
- additional training and/or orientation, 7.46
- course instructors, 8.14
- course content, 8.07
- field experience placements, 8.52
- summer school internship placement, 8.46
- full-year teaching fellow assignment, 8.93
- program orientation, 8.25
- and supervisory support, 8.90

These mean scores demonstrate generally high scores for supports within the program, such as supervisory support and field experience placements. The lowest

score is for additional training, which included instruction on portfolios and an overview of local school systems. The overall satisfaction with the program was 4.04 as measured on a scale of 1 to 5, with 5 being the highest. On recommendations to others, there were three ratings: yes, yes with reservations, and no. The average of the three cohorts was 1.58, signifying a trend toward a “yes” response. For the Praxis II Pedagogy scores, all scores in all certification areas were at least at the state minimum. In particular, the scores for secondary biology and English were significantly higher ($p < .01$) as were the secondary social studies scores ($p < .001$). The researchers reported that the survey data show the ProMAT program to be a success, and this is verified by the feedback they receive from cooperating district personnel.

Schoon and Sandoval (2000) investigated the Northwest Indiana’s Urban Teacher Education Program (UTEP). Within the UTEP, Option II is a graduate in-service teacher certification portion. They investigated why participants chose to enter teaching, and how satisfied are the participants in their preparation through the coursework and fieldwork. They further looked at the beliefs about the effectiveness of UTEP. This program was created at the state level with no input from higher education institutions. It focuses on content-based teaching with all applicants receiving the same preparation, regardless of their intended level of expected teaching. The program lasts 19 months and results in certification. It can lead to a master’s degree in secondary education. Using interviews and focus groups, the authors studied teachers who graduated from the program over a period of five years. This program attracted a higher proportion of minorities than

the traditional program at the university being composed of 23% male, 76% African-American, 15% white, 8% Hispanic, and 1% Asian-American. Of total graduates from the program that are now teaching, 83% are African-American. They found that graduates of the program, principals at schools partnered with the program, district administrators, and faculty have all found the program successful. Furthermore, UTEP graduates that are teaching frequently mentor current UTEP interns.

These studies show how alternative certification programs have a variety of strengths and weaknesses. In this literature, we see that an alternative certification program can be designed to exceed a state's teacher preparation requirements and can serve as a model for all teacher education programs statewide. We also see that at the faculty level instructors can lose a sense of coherence across the program and may need to be focused to teach to specific learning outcomes. A critical look at assumptions reveals that alternative certification may not be meeting all the goals it was set to achieve. However, several studies of programs report a high level of approval from graduates confirmed by referral of others into these programs and a willingness of graduates to mentor new teachers from these programs. This concludes the sub-section on evaluations of alternative certification programs. I now describe the people who enroll in these programs, how programs recruit them, and what keeps them in the teaching profession.

Descriptions of Alternative Certification Participants including Recruitment and Retention

In the research literature focusing on the demographic and other characteristics of the participants in alternative certification programs, I identified eight studies that characterize the demographics of alternatively certified teachers. I then report on the empirical studies concerning the recruitment efforts of several alternative certification programs, as well as the retention of teachers from these programs.

Humphrey and Wechsler (2007) studied seven programs across the United States. They used a case study design to examine the characteristics of participants in seven alternative certification programs. The average age of study participants was 32. The ratio of males to females was about 25:75 overall, but when looking at “single-subject” placements, 41% were male. This compares to 29% male nationally. Minorities comprised 40% of the participants of the seven programs. However, this was partly due to where the programs were located and their stated mission. For instance, the Milwaukee program participants were 80% minority. In several cases, the percentage of minority participants reflected the percentage of minority teachers in the districts in which they are placed. Before teaching, the participants had a high amount of experience with education and educationally related jobs. For instance, 15% were in other positions involving education (not teaching) and 9% were teachers. As far as retention in the teaching profession, 38% of participants planned to be teaching in 10 years. Finally, 18% of participants were full time students before entering their programs. This study

suggests that alternative certification programs have the potential to attract more males, especially at the secondary level, as well as represent the percentages of minorities in the programs as is found in the local community.

Goodwin and Rudkin (2006) provided a description of the Stanley British Primary School Alternative Certification Program's graduates. Using a survey, the researchers were able to contact 162 of the 180 former graduates. This program has an optional Master's degree component, and 87 of the respondents were pursuing this option. Overall, the age range of graduates was 21 to 50, with the average being 27 years old. The survey had a section on recruitment, and the authors found that half of the graduates heard about the program from a former intern, 22% found the program because of a school connection and about 20% were informed by their college and career placement offices. The participants chose the program because of the program's emphasis on field placement (34%), the program philosophy (27%), the completion of a Master's degree (10%), and the accelerated nature of the program (9%). Less than 1% said it was because of the mentoring and support offered. Concerning barriers for entry into the program, 64% stated they would not have entered the program without the stipend. This alternative certification program requires 4 days per week in the field and 1 day per week receiving instruction, and 88% responded favorable to this program structure. Seventy-five percent of responses indicated the graduates were either satisfied or very satisfied with the amount of mentoring provided. Related to retention, 69% of the respondents were still teaching, though the average number of years teaching was 3 with a range of 0 to 7 years. Of the 43

who were not teaching, reasons ranged from “raising children” to managing a business. Thirty percent planned to return to teaching, and 15% did not plan to return.

Shen (1997) provided a look at alternative certification nationwide by using the Schools and Staffing Survey of 1993 (SASS93) data set. In this study, he sought to determine the percent of public teachers that received alternative certification, to compare the traditionally certified and alternatively certified teachers along demographics, work experience, academic qualifications, career pattern; and to examine what and where alternative certification teachers taught. Sampling 14,721 teachers (13,602 traditional, 1,119 alternative) he found no significant gender difference between traditionally certified teachers (23.7% male, 76.3% female) and alternatively certified teachers (25.7% were male, 74.3% female). However, he did find a significant difference in race and ethnicity. Among traditionally certified teachers, 87.2% are white and 12.8% non-white. Among alternatively certified teachers 79.3% are white and 20.7% are non-white. Age was also statistically significant ($X^2(3)=32.48, p<.001$) with current alternatively certified teachers being younger than current traditionally certified teachers. Shen found that 51% of alternatively certified teachers had recently completed study as undergraduates, and 23.8% had previously held educationally related jobs. This compares to 68% and 16.5%, respectively, for traditionally certified teachers. While traditionally certified teachers had a significantly higher percentage of master’s degrees, alternatively certified teachers had a higher percentage of bachelor’s degrees in math, science, or engineering (6.5%) than

traditionally certified teachers (5.4%). Furthermore, alternatively certified teachers were more likely to be teaching in a large city (20.9%) and in a school with a higher percentage of minority students (37.8%) than traditionally certified teachers (10.6% and 26.8%, respectively).

Continuing his studies utilizing national data sets, Shen (1998) conducted further investigation into the link between certification, minorities, urban schools, and teacher characteristics of traditionally certified and alternatively certified teachers. Using a secondary analysis of SASS93 including 13,601 traditionally certified and 1,118 alternatively certified teachers, Shen generated a representative sample of public school teachers certified during the 10 years before 1993. He found that 87% of alternatively certified minority teachers teach in urban areas as compared with 67% of traditionally certified minority teachers. Also, 67% of traditionally certified minority teachers and 89% of alternatively certified minority teachers teach in schools where 50% or more of the student body is composed of minority students. The data revealed that 53% of alternative certification white teachers and 44% of alternatively certified minority teachers were previously undergraduates and Shen suggested that many alternative certification recipients were circumventing the traditional route. Shen noted that, “to conduct a valid assessment of differences among the groups in terms of teacher quality, we would have to compare the groups on other quality indicators – particularly pedagogical skills – in future studies” (p. 35). Shen’s suggestion for future studies indicates that a study of factors on instructional practices is

necessary and interesting. This dissertation study addresses this call for further research.

Goldhaber and Brewer (2000) also compared alternative and traditional certification using the National Educational Longitudinal Study of 1988 (NELS:88). They investigated if certification type impacted student achievement scores in 12th grade math and science. Their sample included 3,786 mathematics students, 2,524 science students, 2,098 mathematics teachers and 1,371 science teachers. Using multiple regression analysis, they found that individual and family background variables, along with 10th grade test scores, account for almost all the variance in 12th grade performance in mathematics and science. Mathematics students whose teachers had a bachelor's or a master's degree in mathematics scored higher than students who had teachers without these subject specific degrees. However, in science the subject specific degrees made no difference. Students whose teachers were not certified to teach in math did not score as high as those with certification to teach math, whether it is standard, probationary, or emergency. Emergency certification in mathematics did not impact student scores any differently than standard certification in mathematics, whether it was traditional or alternative.

Reyes (2003) investigated the relationship between teacher preparation and student achievement in math and reading, specifically with poverty-stricken Hispanic students. She examined a school that was 50% at-risk, 70% low income, 60% bi-lingual education, and 90% Hispanic students, and used a stratified random sample with equal numbers of 6th, 7th, and 8th grade students with equal

numbers of at-risk and regular students to conduct her analysis. The teacher sample included 11 math teachers and 26 English/language teachers, all of which corresponded to the selected students. Of the 150 students, 144 students were in math classes and 104 of those students were assigned to teachers with full math certification. Twenty-one students were assigned to teachers with alternative certification in math. Eighteen were assigned to teachers with temporary permits to teach math, and no students were assigned to teachers certified out of field or to long-term substitutes. Using state achievement data that she converted to national curve equivalent scores (NCE), the NCE math scores showed no significant difference in student scores based on teachers' certification. Furthermore, end of semester grades also showed no significant differences based on teachers' certification. However, math students with alternatively certified teachers experienced a higher degree of grade inflation when comparing end-of-semester grades with NCE scores. The same conditions were found with the students' English content scores. As for how students are distributed to the teachers, traditionally certified teachers taught 104 students, 54% regular and 46% at-risk students. This compares to teachers with alternative certification that taught 71% at-risk students and 29% regular students. Among at-risk students and regular students, no significant differences existed in student scores based on teacher's certification status, that is, the students would have fared as well with either teacher. In reading, at-risk students taught by alternatively certified teachers scored significantly higher on the NCE than at-risk students taught by traditionally certified teachers. Finally, no significant differences were found in

end-of-semester grades by teacher's certification route regardless of at-risk status for both math and reading.

Ritter and Hancock (2007) investigated how certification route and experience level influenced a teacher's classroom management. They sampled 158 public middle school teachers in the southeast United States. These teachers were then divided into four groups: 53 experienced traditionally certified, 45 novice traditionally certified; 27 experienced alternatively certified, 33 novice alternatively certified. In this study, "experienced" was defined as five consecutive years of teaching and "novice" was defined as less than two consecutive years of teaching. Using the Attitudes and Beliefs on Classroom Control (ABCC) Inventory, they measured three subscales of classroom management: instructional management, people management, and behavior management. With this instrument, a high score indicates a more controlling, interventionist approach while a low score indicates a less controlling, non-interventionist approach. Using a 2x2 ANOVA, they found that overall, the experience levels and certification type did not yield statistically significant differences in classroom management scores. However, a statistically significant interaction was found between experience level and certification ($F = 6.7, p < .01$). Traditionally certified, experienced teachers scored significantly lower on the ABCC inventory than the other three groupings: alternatively certified experienced teachers, alternatively certified novice teachers, and traditionally certified novice teachers. This lower score reflects a "less controlling, non-interventionist approach" to classroom management (p. 1209). The researchers

conducted follow up interviews with a sample of teachers, confirming their responses on the ABCC Inventory. This study shows that traditionally certified, experienced teachers become less controlling over time. Ritter and Hancock suggest that alternative certification programs may want to emulate the classroom management curriculum in the alt cert programs to facilitate a more open atmosphere within the classrooms.

Good, McCaslin, Tsang, Zhang, Wiley, Lozack, and Hester (2006) examined how 1st year elementary, middle, and high school teachers teach and analyzed the extent to which their performance met the expectations of the districts they worked in. They specifically examined how alternative teacher education programs influence teaching practices. To investigate these topics, they sampled three groups of first year teachers over three years beginning with 63 teachers the first year, 131 teachers the second year, and 139 teachers in the final year. All teachers were K-12 regular education teachers in their first year of teaching in seven school districts. About half of the districts in the study required new teachers to participate in the study. The researchers used ANOVA to cross 1st year teaching practices with school level (elementary, middle, high school) and type of teacher preparation (traditional bachelor's degree and nontraditional master's degree/postbaccalaureate certification). In all categories, the researchers found that the teachers met the requirements set by the district that employed them. For high school teachers, both post-baccalaureate teachers and those seeking a master's degree had higher mean scores. The THOR assessment provides scores in three areas: Assessment, Classroom Management, and

Implementation of Instruction. Within these three areas, indicator areas are scaled from 1 to 5, where 5 is the ideal description of the indicator and a 1 is considered a poor performance for that indicator. Assessment was the lowest rated area overall (mean of 3.27), Implementation of Instruction (mean of 3.46), and Classroom Management was the highest (mean of 3.60). Only with Classroom Management were non-traditional teachers rated significantly higher ($p < .01$) than the traditionally prepared teachers. However, this includes teachers at all K-12 levels and the researchers suggest that the THOR instrument may be biased toward elementary teachers based on the level and types of interactions teachers have with students.

Harvey and Gimbert (2007) examined differences between alternative certification and traditional certification teachers for their pedagogical knowledge as measured by the Principles of Learning to Teach (PLT) examination and on teaching performance as measured by the Assisting, Developing, and Evaluation of Professional Teaching (ADEPT) instrument. Using a quasi-experimental study with non-equivalent comparison groups, they sampled 932 teachers in their second year of teaching in South Carolina. Of these, 768 were traditionally certified and 164 alternatively certified. Using t-tests as well as one and two way ANOVAs, they analyzed teachers' scores on the PLT and school district evaluator's perception of the teacher's performance on all 10 categories of the ADEPT instrument to see if teacher certification (traditional or alternative), age, gender, race, and highest degree earned were related to any differences in teacher knowledge. They found that traditionally certified teachers scored significantly

higher on the PLT, with a mean score of 174 compared with alternatively certified teachers with a mean score of 169. However, no significant difference was found between scores on the ADEPT based on type of certification. For age, race, and gender, there was no significant difference in teacher's performance. The authors concluded that this study confirms that the certification route does not adversely lead to substantial differences in teacher knowledge.

Gimbert, Cristol, and Sene (2007) studied the effects of the Transition To Teaching (TTT) program that was created to alleviate the shortage of teachers in a southeast Virginia urban district. The authors designed a quasi-experimental study matching six TTT teachers with six teachers from similar schools and classrooms to see if student performance in Algebra 1 was affected. Using Algebra 1 quarter tests (1, 2, and 3) and the state's end of course test they found that students taught by teachers from the TTT program score as well as or better in Algebra 1 than students taught by comparable teachers from a traditional program. A 2x4 repeated measures ANOVA on test scores from the first three quarters and the state's end of course test show that Algebra 1 test scores were significantly different between the two groups ($p < .001$). Follow-up analysis using MANCOVA indicated that students whose teachers were in the TTT program scored lower in the first quarter and then significantly higher for the three other test periods. These data were further supported by the 91% pass rate on the Algebra 1 end of course test by student of TTT teachers as compared with an 84% pass rate by students of non-TTT teachers. The authors pointed out that the initial drop in quarter 1 scores of the TTT teachers may be due to a lack of field experience and

that the TTT program alleviates the mathematics teacher shortage without compromising teacher quality.

As seen in this portion of the literature, alternative certification programs vary in size, demographics and purpose. These studies provide insight into the individuals who enter alternative certification programs and the quality of teacher preparation in these programs. Alternative certification programs tend to attract a broader range of age groups into teaching, as well as increase the number of minority teachers. Several studies suggest that alternatively certified teachers are more likely to teach in urban areas and that they are more likely to teach at-risk students. Furthermore, it appears that certification background does not greatly impact K-12 student test scores in mathematics. However, the study by Harvey and Gimbert (2007) reported that alternatively certified teachers have lower scores on the PLT test, a measure of learning and teaching. This leads one to consider what sort of instructional practices occur in the mathematics classroom of individuals who complete alternative certification programs. This dissertation study probes further into this area to see what instructional teaching practices are used by alternatively certified teachers. Few studies have focused on the instructional practices of mathematics teachers specifically, a further gap in the research literature. I now move to the studies on recruitment and retention regarding alternative certification programs.

The recruitment and retention of teachers have often been cited as means to address the nationwide teacher shortage (Ingersoll 2003). Because my study concerns new teachers from alternative certification programs, research in the

area of recruitment and retention may be valuable in understanding who enlists in these programs as well as what factors are associated with their choice to stay in teaching. In the following paragraphs, I summarize the empirical research base on the recruitment and retention of alternative certification teachers.

Dai, Sindelar, Denslow, Dewey, and Rosenberg (2007) examined the teacher shortage situation in terms of the economic factors that contribute to this situation. One aspect of their study included a secondary analysis of the March 2001 Current Population Survey database to investigate teacher migration rates. They found that teachers migrate from state to state at a rate of 4%, whereas workers, in general, only migrate at a 3.6% rate. However, further analysis of public school teachers found that they migrate from state-to-state at a rate of only 2.9% compared to a 4.7% rate for other professionals. They noted that on a national level this is good news, but suggest that from state to state the percentages may vary, causing some states to have increases in teacher supply while others have shortages. They suggested that directors and developers of alternate route programs consider where their applicants live and where they plan to work in the future.

Nagy and Wang (2007) investigated issues of support and retention in New Jersey as teachers enter the profession from an alternate route program. They surveyed 155 alternate route teachers in 33 high schools along with 36 principals. They found that 61% of teachers were between 26 and 44 years old and 33% were between 45 and 65 years old. Half of these teachers were in their first year of teaching. While 18% of the teachers were teaching out-of-field, 61% were

teaching in a field unrelated to their previous occupation. Of the alternative route teachers hired in the spring and summer, 88% and 90%, respectively, remained in teaching the following year whereas only 79% of the teachers hired in the winter remained the following year.

Pullen (1998) used several national data sets to investigate the correlation between science teacher certification standards and the supply of science teachers and the correlation between salary and the supply of science teachers. She found that shortages in physical and earth sciences were positively correlated with a state requiring fewer hours for its broad-field science endorsement. Shortages in biology, chemistry, and physics teachers were positively correlated with a state having a broad-field science endorsement. A shortage of science teachers within a state was positively correlated with the state having more science subjects in its broad-field science endorsement. No significant correlations were found between science teacher supply and a state's reciprocity with other states. The number of member states within a state's reciprocity pact was positively correlated with a state's shortage in science teachers. "A significant negative correlation was found between a shortage of chemistry, physics, physical science, and earth science teachers in a state and the existence of alternative certification in that state" (p. 749). More hours for a single-subject endorsement in science positively correlated with a higher teacher salary index. States with shortages in biology and chemistry teachers were more likely to have a lower teacher salary index.

Tai, Liu, and Fan (2006) studied math and science teacher attrition on a national level using longitudinal data from the Schools and Staffing Survey

(SASS) of 1999-2000 and the Teacher Follow-Up Study (TFS) of 2000-01. Their sample was composed of 671 teachers, 346 taught mathematics and 325 taught science. Of these, 270 remained in the same school, 203 moved to a different school, and 198 left teaching. In particular, school demographics, teacher demographics, number of years teaching at their current school, satisfaction variables, and certification were the variables they investigated. They found that of the 671 teachers in the sample, 522 were traditionally certified and 149 were alternatively certified. Of those teachers that stayed in the same school, 42.9% were traditionally certified teachers, and 29.5% were alternatively certified teachers. For moving to a different school, 27.6% were traditionally certified, while 39.6% were alternatively certified. Finally, 29.5% of traditionally certified left teaching, and 30.9% of alternatively certified teachers left. Including several variables for control, certification was not found to be a statistically significant predictor for moving to a new school or for leaving the profession. The two most significant variables for predicting a teacher's decision to leave or move to another school were "general satisfaction" and "number of years at the current school" ($p < 0.01$). In addition, new teachers were more likely to leave the profession than those who had been teaching more than three years ($p < 0.01$). School demographics were only able to predict 1.3% of the total variance in a teacher's decision to move between schools or leave teaching.

Abell et al. (2006) examined recruitment strategies for an alternative certification program to identify outcomes of various strategies and to identify the gatekeepers of the program, both intentional and unintentional. Using surveys and

interviews, they use a case study of cohort recruitment for two years' of recruitment. They identified two groups within the recruits: "career changers" and "homecomers" (p. 170). Career changers are successful in the workforce but eventually choose to begin teaching. Homecomers are those who decide to teach while undergraduates but decided to wait until their degree in mathematics or science is complete. For Cohort 1, 22 people applied of which 19 were accepted into the program. Of the 22 applications, 11 had heard of the program from an advisor or faculty member at this institution. The internet web site provided the avenue for four other applicants, as well as three more from administrators at partnering schools and three were referred by friends and family. The program was created to enroll 30 students, however only 19 students joined the first cohort. This led to a reevaluation of recruitment efforts resulting in a much earlier start to recruitment and utilized many sources not previously used. These included a toll free number on all materials, billboards on interstates, making financial incentives more noticeable and presenting information at 15 other higher education institutions. The result was 46 applications and 39 accepted students into the second cohort. Despite planning and rethinking advertisements for the program, the university advisors, faculty, and staff were still the main source of applications, although the other efforts moved them beyond the goal of 30 students. Abell et al. also identified gatekeepers, those parts of the system that regulate entrance, and designated them into two groups: intentional and unintentional. Intentional gatekeepers include entrance criteria, such as undergraduate grade point average and GRE scores. Others include application

deadlines, time required for certification, and financial incentives. Program personnel needed a good knowledge of the program so that inquiries were answered accurately. Geography was an issue for many people, and although the program was designed with rural participants in mind, the first Cohort was composed of people entirely from the university's town. Unintentional gatekeepers included College of Education certification officers, age of participants, tenacity of applicants in requesting specific information, internet-savvy individuals, institutional reputation, word of mouth, and even luck. Categories such "career changers" and "homecomers" provide focus in future recruitment efforts as well as inform program directors in course offerings and development by documenting the backgrounds these students have. Knowledge of institutional or other gatekeepers allows program coordinators to make sure these barriers serve their proper purpose in ensuring teacher quality while still encouraging application to the program.

In this section, we see that directors and planners of alternative certification programs need to consider who enrolls in these programs and where they teach. Furthermore, states with shortages are likely to grant alternative certification within the areas of shortages, which change with the conditions within the state. The research shows that many alternatively certified teachers are likely to change schools early in their careers, as well as possibly leave the state or region in which they were certified. The time of year an alternatively certified teacher is hired can predict the likelihood of that teacher staying in the profession, something for program placement offices to heed as graduates of these programs

look for jobs. Finally, the best predictor of a teacher remaining in the same school is satisfaction with the job, something that can be difficult to anticipate.

Perceptions of Support, Mentoring, and Preparation

The literature of alternative teacher certification includes many studies related to the effects of alternative certification routes on the teachers' perceptions of school support, mentoring, and preparation to teach. In the following paragraphs, I summarize the primary findings of these studies.

Ilmer, Nahan, Elliott, Colombo, and Snyder (2005) examined a sample of 178 teachers in the first year of the Limited License to Instruct (LLI) program located in Detroit, Michigan. They investigated the attractions of the LLI program to these individuals, what impact the online curriculum for the program, how the use of cohort groups impacted their learning, and how supported program participants felt during their first year of teaching in the urban Detroit schools. They found that individuals enrolled in the LLI program primarily for certification, a master's degree, and job stability. Concerning Online Instruction, nine themes emerged with the majority of responses being the positives and negatives of online instruction, the convenience of online instruction, and the demands and tasks associated with online instruction. Alternative certification students expressed concerns as about interacting with parents, low salary, and the extent of principal/administrator support. Participants greatly valued the support of the building principal, and expressed frustration with a lack of administrative support. The teachers saw mentors in a positive light, with many more participants reporting positive experiences rather than negative. They appreciated

having a mentor in the same building. Those with mentors located off-site expressed difficulty in receiving mentor support.

Simmons (2005) investigated 18 “highly successful” alternatively certified teachers as identified by their principals and district administrators. She used semi-structured interviews to determine who became an alternatively certified teacher, what motivated them to change careers, and how they have approached learning to teach. Simmons found that most teachers find themselves in a place of needing “generativity” as defined by Erikson (1959) where people exhibit a need to contribute meaningfully to the next generation. Simmons claims the need for generativity motivated them to change careers so that they could feel that they were “making a difference” with their careers. A secondary theme was “time.” Participants cited important time-related factors for pursuing a career in teaching such as summers off or less time spent traveling for work, even though this choice of career came with a lower salary. Minor themes were present in other teachers, such as a lifelong desire or dream to teach. As for their approach to learning to teach, some teachers reported a trial and error method for learning to teach, while another reported a slow “evolutionary” change in teaching practices (p. 39). Participating teachers viewed their university coursework both positively and negatively. On the positive side, some teachers appreciated being able to identify issues and have their own experiences validated by educational theories and research. Many teachers felt frustrated by the coursework in their certification programs, as it did not demonstrate value for their prior adult experiences. They reported that much of the coursework was targeted for 18-22 year olds who

lacked the parenting and community involvement that many older students brought to the class. Teachers reported that their mentors, both formal and informal, were critical for their success in their first year of teaching. The most commonly cited mentor assistance involved connecting alternative certification teachers with their enculturation into the school setting. These teachers viewed professional development as very helpful and most beneficial when they were able to work with groups of other teachers on curriculum and new teaching strategies.

Bey (1992) studied the support and experiences that beginning alternatively certified teachers received at their schools. Her study involved the collection of data through survey research describing the realities experienced by new teachers from alternate programs. She examined 26 alternatively certified secondary math, science, or foreign language teachers with little or no previous teaching experience. Of the 26 teachers, 19 were female, and seven were male. Using a 96-item survey, she identified four broad categories and ranked them according to the teachers reported need of support in those areas. The first category was Assessment of Performance, a category focused on preparing for the state assessment portfolio, preparing for assessment of their teaching, and fulfilling activities for completing their certification program. Participants responded that this category was the most important. Their expectations of mentors were mostly to gain assistance in meeting requirements for certification. The second broad category was Instructional and Management Skills. This category includes topics such as teaching methods, classroom management, and

motivational techniques to use with students. The third broad category was Reflective Thinking and Feedback. This category included topics such as analyzing student failure, analyzing their own teaching, reflecting on teaching, and scheduling time to discuss instruction. The final category was Operational Functions. This included learning about school policies and procedures as well as getting to know other faculty and staff. Overall, Bey found that new teachers often received less support than they expected, although the demands on the new teachers were high in terms of paperwork and meeting requirements for certification. Bey speculated that mentor teachers' teaching quality may have declined due to the work required to meet the mentees' requests for assistance.

Tissington (2006) used a phenomenological approach to investigate the lived experiences of 27 candidates in a West Florida university alternative certification program. Of the 27 candidates, 22 were female and five male, including 19 white, 7 African-American, and 1 Hispanic. Twenty participants taught at the secondary level. Tissington used her participation as the program director and an instructor to determine how alternative certification participants "perceive, make sense of, and describe mentorship to others through their individual and collective lived experiences" (p. 38). She developed four categories to characterize the expectations of mentee teachers for the role of the mentor teacher: (a) providing insight into school politics, (b) serving in close proximity with the mentee, (c) developing a relationship with new teachers, and (d) providing ideas for dealing with classroom management issues.

Myers, McMillan, Price, Anderson, and Fives (2007) conducted an ethnographic study of five participants in the *Recruiting Educators through Alternative Licensure* (Project REAL) program in Texas. Of these five, two were Hispanic and three were Caucasian. The researchers sought to: (a) determine if Project REAL prepared participants for future teaching in high need schools, (b) examine what participants' perceptions of how their relationship with their mentor prepared them for future classrooms, (c) examine participants' perceptions of high quality teacher preparation, and (d) examine the extent to which particular alternative certification program characteristics can make up for the short time of preparation. To examine these issues, they interviewed five teachers, and conducted in-depth interviews with three of them. They also interviewed three mentor teachers. All teachers were placed for their first-year teaching internships at "high need" schools and all taught at the secondary level in areas of shortage (math, science, foreign language). Two motifs emerged: Preparedness and Mentoring. Within the motif of Preparedness, the new teachers' responses included themes of lesson planning, flexibility, relationship building, performance, and commitment (p. 23). To them, preparedness included enthusiasm for the content area and proper planning for each day. These participants saw performance as a part of being prepared to teach, as many interviews indicated the artistic side of teaching that involves performing in front of students. The second motif was that of Mentoring Support. The data from both mentors and mentees revealed that proper mentoring requires adequate time and

dedication to relationship building. Having time was the primary necessity since many topics were available for discussion on a daily basis.

Utsumi and Kizu (2006) conducted two studies of alternative certificated teachers that drew on a database of 517 first year teachers, 118 mentor teachers, and 52 site administrators. This sample of first year teachers was 59% non-white and 32% male. Among the new teachers, 70% had prior career experiences and 43% were over age 30. The researchers investigated the perceived needs and assistance received from mentor teachers. They also examined the influences on teaching while considering the teacher variables of race/ethnicity, gender, prior experiences, age, and beliefs. The findings revealed discrepancies in the amount of perceived support received by new teachers as compared with the amount of perceived support provided by mentors. The mentors reported higher amounts of support given than the new teachers reported receiving. The new teachers' age, race, previous careers and gender were not significant factors in amount of support received from mentors. The mentors and beginning teachers reported similar beliefs about the role of family support, basic skills, and motivation on student success. However, the two groups disagreed slightly about the impact of SES on student success. No mentoring areas were reported as needing less support, and no domain was listed as most important.

Dukes and Jones (2007) investigated the issues that alternative certification students discussed online during their first year of teaching. They analyzed student responses to consider how "asynchronous online discussions positively impact the education of online participants?" (p. 25). The researchers

examined one cohort of alternative certification students at one university composed of 18 graduate students during their first year of teaching, seven Nationally Board Certified mentor teachers, and two university faculty members. Using previous research on traditionally certified teachers, the forum contained the eight categories: Community Bulletin Board, Curriculum and Instruction, Professional Identity, Classroom Management, Individual Students, Policy and Politics, Technology, Working with Colleagues and Family. Over five months the responses in the forums were uniformly distributed. Community Bulletin Board, a place for posting personal or non-school related topics, had the most responses. However, Curriculum and Instruction was the next highest with 20 discussions and 84 responses. Professional Identity had 17 discussions and 58 responses, Classroom Management had 14 discussions and 53 responses, Individual Students had 10 discussions and 39 responses, Policy and Politics 8 discussions and 58 responses. Technology had only five discussions and seven responses, and Working with Colleagues and Family 2 discussions and four responses. Only Technology and Working with Colleagues and Family had a mean number of responses of two or fewer. This research suggests that alternatively certified teachers are interested in issues of curriculum and instruction and professional identity. Classroom management, often cited as a major issue for new teachers, ranked lower than these two categories.

Arbaugh, Abell, Lannin, Volkmann, and Boone (2007) investigated how interns, mentor teachers, and university faculty viewed five internship models for teaching internships in an alternative certification program. Studying data from a

half-day meeting with the stakeholders in the program, along with follow up interviews with 10 interns, 10 mentors, and three university faculty, they found that each group had distinct choices in internship model and unique reasons for preferring the model. The analysis of the data led to three distinct categories, reflecting the differing views of the stakeholders. Accelerated post-baccalaureate interns preferred the models that allowed the internship to be a full academic year with the internship lasting for half a day five days a week. They cited time for building relationships with students, experiencing a full school year as a teacher, seeing more content in sequence, and managing life (classes, jobs, and family) as reasons for choosing these models. The authors noted that the issues used to arrive at this conclusion are quite different than issues they hear from traditional undergraduates. Arbaugh et al. stated, “These data provide evidence that our post-baccalaureate certification students have a different set of needs than our traditional students when it comes to the field-based internship” (p. 197). Mentor teachers saw a yearlong internship as best split between two host teachers, reflected in three of the models. They suggested that more teachers might sign up to be mentors if they only had to deal with mentoring for one semester rather than two. They also expressed concern about sharing their classes for such a long time. Furthermore, they felt it was important for interns to experience teaching for a full day, rather than just a half-day at a time. They thought that interns may get the idea that teaching is not as mentally difficult and that the first year teaching alone would be more than the intern was expecting. The authors point out that the mentor teachers were most accustomed to dealing with an internship of the

traditional model, and that they found more pros for models with which they were familiar. University faculty felt that the year long program at one school site was beneficial because the interns would develop relationships with not only the students, but also the building administrators, staff, and district administrators that might not occur on a shorter internship. There would also be the opportunity to see students develop over the course of the year, and that this experience would be useful within the university coursework the interns were involved in.

Furthermore, the coursework for the program had eliminated a course on school culture, and the faculty believed that a year at one school would provide an in-depth view of school culture that would provide further discussions to integrate within the other courses. Faculty expressed concern about placing interns at two schools, amounting to twice the legwork to place students, and worried about competing with placement of the traditional students in their student teaching.

Johnson, Birkeland, and Peske (2005) applied a case study methodology to investigate state policies on fast-track certification programs. Specifically their findings concerning the questions of how the participants felt about the program after their first year teaching and in what ways they felt most prepared to teach and least prepared to teach are relevant to this review of the literature. The authors conducted interviews with program directors, selected faculty members, and between 4 to 8 participants in each of 11 programs in three states during the summer of 2002 and the following 15 months. They found that despite the “fast-track” view of the programs studied, the participants still expected to receive instruction and student teaching to have them ready to teach in the fall.

Participants expressed a desire to have more content-based pedagogy instruction but overall were satisfied with their preparation. The participants reported that they were looking for a high-quality preparation that would give them enough skills to begin teaching following the two months of summer preparation.

Iyer and Soled (2007) investigated the differences regarding dispositions or perceived preparedness between teachers in traditional undergraduate teacher education programs, master's degree programs that led to certification, and alternative certification programs. They looked at 86 traditional route pre-service teachers in their 4th year of study, 55 students in their final year of a 5th year master's program, and 37 enrolled in an alternate route program. Response rates were 70% for traditional, 81% for master's level, and 45% for alternative certification. Using a MANOVA, the dispositions and perceived preparedness were crossed with the three routes to certification. No statistically significant differences were found in perceived preparedness between the three routes to certification. However, along the construct "ethics and justice" the master's level students reported a statistically significantly higher level than the undergraduates and the alternate route students. Between the alternate route students and the undergraduates, there was no significant difference. The researchers posit that the higher level of ethics and justice reported by the master's level students could be attributed to the greater number of classes they have taken, specifically two courses: "Schooling and Teaching in America" and "Social Inequalities" (p. 72).

Finally, Zientek (2007) conducted a massive replication study to answer the questions: (a) Do novice teachers differ by certification route in their sense of

self-efficacy, perceptions of preparedness to teach, overall preparedness, mentoring experience, reasons for entering the classroom, plans to remain in teaching, and classroom preparation? (b) Are ATC programs diversifying the teacher population? (c) Does a teacher's perception of preparedness and self-efficacy depend on certification route, classroom preparation, mentoring experience, prior classroom experience, or entrance and exit qualifications? (d) Does a teacher's sense of overall preparedness depend on classroom components, mentoring experience, prior classroom experience, or entrance and exit qualifications? and (e) Does the overall preparedness depend on age and prior career experience?" (p. 962). She identified a sample of 1197 teachers 415 which were traditionally certified, 183 were post-baccalaureate certified, 7 through a local district, 223 certified through for-profit agencies, 97 through community college, and 270 through a regional service center. Furthermore, 610 were 1st year teachers, 291 and 296 were 2nd and 3rd year teachers, respectively and 5% reported having a major in mathematics. Of these teachers, 80% were female, 64% white, with an average age of 34. Along ethnicities, 26% were Hispanic and 5% African-American. All participants were in their first 3 years of teaching. She used multivariate analysis of variance (MANOVA) and Canonical correlational analysis (CCA) on "perceptions of preparedness." She found that the certification route completed explained about 1% of the variance in teacher efficacy, about 2% of teachers' perception of preparedness, and about 1% of teachers' perception of overall preparedness. Using analysis of variance (ANOVA) on "preparedness to teach" results indicated that 3-6% of variance in teachers' perception of

preparedness of Promoting Student Learning, Understanding Learners, Teaching Critical Thinking and Social Development, and teachers' overall sense of preparedness. This test indicated that traditionally certified teachers scored highest while teachers certified through for-profit private agencies scored lowest. However, participants certified through for-profit agencies had the most positive mentoring experiences. Alternative certification programs appear to bring in more minorities and people with higher degrees. Age accounted for about 2% of the variance in overall preparedness to teach regardless of preparation type or program. Overall, Zientek concluded that teacher preparation programs of all types are producing teachers with high efficacy. Positive mentoring experiences are able to outweigh some negative aspects of beginning teachers' experiences. Non-traditional certification programs are recruiting more minorities and older individuals, but are not recruiting greater numbers of mathematicians, scientists, and engineers.

These 11 studies demonstrate the value of effective mentoring, certification preparation, and other teacher support that alternative certification programs provide. Overall, they suggest that mentoring is an important support during beginning years for alternatively certified teachers. These new teachers seek help in navigating not only certification requirements, but also the bureaucracies within their new schools. Mentoring requires time and investment in building relationships and is best done within the school building or through an online format. New teachers see mentors as critical elements during the beginning year of teaching.

These studies provide important insight into the factors impacting teachers from alternative certification programs. However, none of these studies specifically examined mathematics teachers. Furthermore, while they reported teachers' perceptions of mentoring, preparedness, and support, little information is provided on the actual impact of these factors on the classroom teaching of teachers who are alternatively certified. This dissertation study begins to fill in this missing gap in the research literature by examining the factors (e.g. mentoring and other support structures) influencing the instructional practices of alternatively certified teachers.

Professional Identity and Efficacy Studies

The final category I explore in the research literature on alternative certification concerns studies of professional identity and efficacy. These studies were typically designed to assess perceived preparedness of traditionally-educated teachers and alternatively-educated teachers, comparing the results on measures of preparedness. While some studies demonstrated differences in perceived preparedness between groups, others did not demonstrate differences. Investigations of alternatively certified teachers who are placed in urban schools and the development they undergo during their first year are also included in this subset of the alternative certification literature. In the next five paragraphs, I summarize the studies that document the identity development and efficacy of teachers involved in an alternate route to teaching certification.

Proweller and Mitchener (2004) conducted a study of teacher identity in the first year using 15 teachers involved in Chicago Public Schools' Middle

Grades Science (MGS), an alternate certification route. The MGS program is highly selective, with only about half of the applicants accepted. For this particular cohort of 15 teachers, the ages ranged from 24 to 57, with average age of 34. Data collection consisted of individual, formal, structured interviews, weekly seminar meeting notes and prompt responses, and field notes of classroom observations. Another data source was weekly visits to teacher classrooms with occasional co-teaching with a mentor/researcher and always included a time of discussion with the observer after the lesson. From this study, two themes emerged: Identity Options for Urban Youth and Curriculum in Context. Within the first theme, the researchers found that many teachers left professions where their impact on students was limited, and they did not establish meaningful relationships with others. The participants saw teaching as the profession in which they sought long-term impact on these urban youth through establishing meaningful relationships. As each teacher had a background in the sciences, these teachers felt that students needed science to be successful in life. Within the second theme, Curriculum in Context, the teachers forged relationships with these students and their families and communities through the science curriculum. The teachers saw science as a way to teach responsibility in society and for the planet. They also saw science as interconnected with politics. Teachers viewed teaching science as an avenue for giving urban youth a chance to succeed and they saw education in general as a way to address issues of equity, social justice, and health. The teacher interns realized that they needed to use teaching as a tool to

bring a sense of power to the students, who were typically poor and showed or expressed a sense of “powerlessness.”

Forsbach-Rothman, Margolin, and Bloom (2007) studied 100 teacher candidates: 19 graduate students, 39 undergraduate students, 42 alternate-certification students to determine if the three groups exhibited different levels of efficacy as measured by the “Personal Teaching Efficacy subscale of the Teacher Efficacy Scale (Gibson & Dembo, 1984)” (p. 32). Using ANOVA, the researchers found that the on the Personal Teaching Efficacy subscale the undergraduates scored significantly higher ($p < .01$) than both the graduate level and the alternate route participants. Between the graduate level and the alternate route participants, no statistically significant difference was found in teaching efficacy. The researchers also administered an open-ended questionnaire about most important aspects of their preparation programs. Of the seven categories reported three included issues of classroom management and behavior, and three targeted planning, teaching, and lesson modification. The other category included camaraderie with other alternate route teachers. Overwhelmingly, classroom management aspects were the most important along with dealing with student misbehavior. The researchers concluded that preparation programs, both traditional and alternative, should place more focus on the issues the participants perceive are important.

Isaacs et al. (2007) studied 194 new teachers in three districts in Florida. Of these 194 teachers, 79 received certification through alternate routes. The researchers set out to “investigate teachers’ confidence in their preparation, to

identify differences in confidence in teachers based on their route to teacher certification, to identify areas that require strengthening in teacher preparation and induction programs, and to identify any differences in likelihood of remaining in the field and/or in their district or school based upon preparation path” (p. 6). Isaacs et al. found that almost two-thirds of alternatively certified teachers said they would add another specialty to their certification type in the future. However, the traditionally certified teachers in their sample scored significantly higher feelings of preparedness in almost every category including those concerning lesson planning and tasks, using various learning styles, teaching students with disabilities and ELL students, assessment, and meeting state standards. Categories not statistically significant included time management, behavior management, use of technology to enhance teaching, ethics and professional behavior, and administering the state test. The researchers suggested that further preparation and mentoring should target areas where teachers felt least prepared.

Mayo, Kajs, and Tanguma (2005) compared first year teachers to determine if a tailored program involving the use of technology in the classroom would impact new teachers’ use of technology in the mathematics classroom. A two-part follow-up study used alternatively certified teachers from the university’s program as a comparison grouping. All teachers were in their first year of teaching, and all participants were prepared at the same university. For the first part of the two-part follow-up study, 24 traditionally certified and 21 alternatively certified teachers were compared on three scales at the end of the first school semester. The traditionally certified teachers showed significantly

more ($t = 1.82; p < .05$) efficacy than the alternatively certified teachers. For the second part, the researchers compared another group of teachers with 30 traditionally certified and 21 alternatively certified teachers at the end of second semester. The first two scales remained the same with the researchers modifying the efficacy scale to include efficacy in teaching with technology. This time no significant differences found in any of the three categories. A follow-up questionnaire measured the amount of time the teacher uses technology and time students spend using technology in the classroom. For student use of technology, the traditionally certified teachers reported greater use of technology, 2.6 hours per week compared with 1.49 hours for alternatively certified teachers ($F = 5.5, p < .02$ level). They found no statistically significant difference between the traditionally and alternatively certified teachers' use of technology for teaching purposes. This study found that traditionally certified new teachers report higher teaching efficacy but that alternatively certified teachers also feel effective in their use of technology.

Costigan (2004) conducted a qualitative study of 38 teachers of the New York City Teaching Fellows program, an alternative certification program created to bring individuals from other professions into hard-to-fill urban classrooms. These teachers began their preparation in the summer and started teaching in the fall. Costigan studied them prior to beginning teaching through their first year in the classroom. Using interviews, journal entries, and "brown bag" lunch discussions, he was able to observe changes in how teachers thought they would teach and what changes they thought they would make in students' lives

compared with their thoughts and concerns once the school year began. He found that teachers had initial theories and “noble ideals” of how their teaching would transpire but that these ideas changed as they began the struggle with how to “get through” each day (p. 135). Costigan found that the teachers initially viewed entire classes of students as disruptive but through group discussions and personal reflection they settled on the idea that there are 3 or 4 “bellwether” students in each class that are the gauge by which classroom control could be measured (p. 136). A dominant theme throughout the study was “control” and “management” and the participants did not view their preparation coursework as useful unless it had immediate practical applications. Costigan concluded that preparation programs should spend more time focusing on issues that teachers find relevant and that coursework should not be outside this foci of involvement and should help these teachers identify names for their issues so that they can focus on the problem specifically and not generalize issues to larger situations.

This subset of the literature on alternative certification studies of professional identity and efficacy demonstrates some of the similarities and differences of the perceived preparedness of traditionally-educated teachers and alternatively-educated teachers. A strong theme across these studies suggests that teacher preparation programs should focus on issues identified as relevant and meaningful to the program participants. These issues vary from general issues of classroom management to specific topics such as teaching English language learners. In addition, the research has important implications for studying those appointed to teach in urban areas, one of the targets of alternative certification

policies aimed at teacher shortages. Within these studies, a lack in specific investigation exists into the identity and efficacy among mathematics teachers. While these studies provide a broad look at secondary teachers in general, they provide little insight into the preparation of mathematics teachers.

This concludes the section on alternative certification research. As we have seen, much research of alternatively certified teachers has been conducted, but in several areas, there are gaps that need filling. In particular, studies of mathematics teachers from these programs usually lack a focus on classroom observation and instead rely on measures from certification tests. Furthermore, even fewer studies follow teachers beyond two years. My study will begin to fill this gap in the research and provide further insight into the teaching practices of mathematics teachers. I now move to the second section in this literature review, that of factors impacting teachers' instructional practice. While some of these studies involve alternatively certified teachers, the focus of the section is on instructional practices, not the status of certification.

Factors Impacting Teachers' Instructional Practices

In Chapter 1, I provided a framework in Figure 1 that represented five broad categories of influences on alternatively certified mathematics teachers' instructional practices. The previous section summarized the research literature on certification programs. In this section, I will discuss the research base for the remaining categories from Figure 1: school context factors, professional development involvement, knowledge of teaching, and beliefs. In each of these areas, the reader must keep in mind the influence of these factors on a teacher's instructional practice.

School Context Factors

This section contains several studies that embody some of school-level factors that researchers have studied and found to influence teachers' instructional practices. I begin with a study by Swanson and Stevenson (2002) that draws from a national data set to give the reader a broad view of the impact of school level factors. Following this broad study, I highlight studies that show other factors, such as class size, poverty levels, ethnicity, student tracking, and finally a study by Opdenakker and Van Damme (2006) that takes a closer look than Swanson and Stevenson (2002) at some of the school and classroom factors associated with instructional practices.

Swanson and Stevenson (2002) studied how instructional practices are shaped by organizational and state-level policy implementations. Using the 1996 NAEP 8th grade mathematics data set, which includes 19,167 students in 2,767 schools within 40 states, they analyzed a composite measure of 16 teacher-reported instructional activities that align with the NCTM (1989) recommendations. Specifically they focused on pedagogy, math topics and skills, and classroom assessment. Analysis at the classroom level found that 75% of the variation in instructional practices was caused by classroom-level factors. Another 22% was attributable to school-level factors. A higher number of students in class served as a positive predictor of the use of standards-based instructional practices. Algebra and pre-algebra in the eighth grade were more likely to be taught with standards-based practices than 8th grade math. Finally, teachers with more years of experience in teaching mathematics had higher levels of standards-based instructional practices. At the school level, smaller schools tended to have higher

levels of standards-based instructional practice, as well as schools with higher levels of spending on instructional materials. Schools with a curriculum specialist were also correlated with higher levels of standards-based instruction. At the teacher level, teachers with a high level of knowledge of NCTM standards and teachers with a positive disposition toward standards-based practice both exhibited significantly higher levels of standards-based instructional practices.

McKinney and Frazier (2008) surveyed teachers to see what sorts of instructional practices mathematics teachers in high-poverty schools use, and how often. Their study included 24 White teachers, 28 African-American teachers, 9 Hispanic teachers, and 4 Other-ethnicity teachers with ages ranging from 25 to 56 years old. The authors found that manipulatives, both physical and virtual, were used infrequently in these high-poverty classrooms. Lecture was reportedly used frequently or very frequently 75% of the time, and “drill and practice” was used over 96% of the time. Memorization of algorithms, procedures, and rules also dominated the instructional practices, accounting for over 88% of the reported practices. Students frequently or very frequently work independently 88% of the time. However, calculators were reported as used very frequently by 100% of the teachers, and teachers reported using higher-level questioning over 90% of the time.

Rice (1999) sampled 4,932 mathematics classes and 3,828 science classes from the NELS:88 data set to see how class size affects the instructional practices of high school math and science teachers. Particularly in mathematics classes, she found that class size significantly affects mathematics classes in the amount of

time spent working in small groups, the amount of time used for innovative instructional practices, and the amount of time spent in whole-group discussion (p. 226). In large classes, math teachers used fewer of these three instructional practices than in smaller classes. Teachers who spent more time planning were more likely to use innovative instructional strategies when class sizes were small. In larger classes, high achieving students were assigned less homework and low achieving students are assigned more homework.

Lubienski (2002) investigated how Black-White gaps in mathematics achievement, as measured by NAEP data could be related to instruction-related variables that were not attributable to student SES differences. She found significant differences in the ways that teachers of Black students used computers compared with teachers of White students. Black students were more likely to experience computer usage for drill and practice while White students were more likely to use computers for simulation and demonstration of concepts. These differences held in both the 1996 and 2000 data and were not affected by SES. The use of calculators revealed differences as well, with 32% of Black students reporting the use of calculators “almost every day” as compared to 61% of White students. Again, these differences were unrelated to student SES. Black students were more likely to be assessed with multiple-choice tests than White students. Monthly assessment with multiple-choice tests was reported at 63% for Black 8th graders and 38% for White 8th grade students. Even after controlling for student SES this gap held. These data show that although the instructional practices with technology and assessment practices using multiple-choice tests may not be

deliberate, student race is a likely indicator of how teachers use computers, calculators, and multiple-choice tests.

Raudenbush, Rowan, and Cheong (1993) investigated the effects of tracking in high school among mathematics, science, social studies, and English classes. Their hypotheses centered on teachers' use of higher-order thinking objectives in relation to the various tracks within these subject areas. They speculated that since students in different tracks were taught differently, especially in terms of expectations beyond basic skills, then there should be variation within teachers when looking at the classes they teach. They purposefully chose 1205 classes taught by 303 teachers in 16 high schools in California and Michigan to represent diverse state policies, district resources, school organization, and student composition. They found that teachers with higher-order objectives in math, science, and social studies did not necessarily leave out emphasis on lower-order objectives within their classes. Higher track mathematics classes were found to have a significantly higher emphasis on higher-order thinking objectives compared to the lower track classes. The same held for science classes. English and social studies classes also showed significant differences, though not as large as in math and science. There were also differences between honors level courses and the regular track courses.

Opdenakker and Van Damme (2006) studied the effects of teacher characteristics and teaching style on classroom practices as well as what class, teacher, and school-related factors affect good classroom practice. Over two years they examined 132 mathematics classes comprising 78 teachers in 47 schools.

They found a relationship between job satisfaction and the degree to which teachers use a learner-centered teaching style. Those with a higher level of job satisfaction used a learner-centered teaching style more frequently. Mathematics teaching style was affected by school factors, where 20% of the variance in the content-centered style of teaching is related to the school. However, the school factors did not affect learner-centered teaching styles, classroom management skills, or mathematics teacher job satisfaction. Although individual classes seemed to be a factor in teacher instructional support offered to students, the authors did not find any variance in instructional support attributable to the school level. Learner-centered teaching style explained 15% of the variance in instructional support. They also found that teachers with a low level of job satisfaction invest more effort in their high-cognitive level classes and less effort into their low-cognitive level classes.

In this section, I have shown some of the research documenting the effects of various factors on instructional practice. While teachers vary in instructional practice, schools also play a role in how these practices are implemented. Any study of instructional practices should be conducted with some attention paid to these, and other, factors. Next I move to an area that directly affects teachers, that of professional development.

Professional Development

While the research on professional development is extensive, I have chosen these studies to illustrate some of the influence professional development can have on a teacher's instructional practice. The first study outlines features of professional

development associated with a change in instructional practice, and two studies were derived from an extensive professional development project focusing on mathematics teachers. The final study reports on a sample of teachers from Missouri that provides some insight into what teachers expect as well as their previous experiences in professional development.

Desimone, Porter, Garet, Yoon, and Birman (2002) investigated the effects of professional development on teachers' instructional practices. They found six features of professional development that were related to changes in teaching practices. If the professional development was oriented with a reform perspective, it was likely to change teaching practices. The professional development activity also needed to incorporate active learning strategies, coherence with teachers' goals, and a focus on mathematics content. Professional development that focused on the use of technology and using technology in assessment and teaching increased teachers' use of technology in instructional practice. Furthermore, professional development activities that included collective participation from the same school, department, or grade level also impacted changes in instruction. Finally, professional development that focused on specific teaching practices increased teachers' use of those practices.

In the Quantitative Understanding: Amplifying Student Achievement and Reasoning [QUASAR] project, Silver & Smith (1996) describe classrooms in urban middle schools throughout the US where mathematical communities of discourse are created and fostered. They document the challenges teachers have in adjusting instruction toward a climate of communication, both verbal and written,

and focus on two teachers, each making changes away from traditional styles, but struggling to see the vision to fruition. They suggest that in order for teachers to be successful in the transition from traditional teaching to a mathematical discourse community, there must be a move away from teacher isolation toward collaborative communities.

Drawing on data from the QUASAR project, Forman et al. (1998) described the teaching practices of Ms. Kingsley as she orchestrated student discussions about conversions of area units. In this classroom, following the introduction of the problem, the teacher presented the students with the norms expected in the following discussions. Students worked in groups to formalize their mathematical solutions and later presented their conclusions in a whole-class setting. Ms. Kingsley told them that not only are the mathematical solutions expected, but also the reasoning and justification. She pointed out that she had seen many different answers and that each solution presented would need to be under scrutiny so that a correct solution could be agreed upon. During the presentations, the teacher was in the back of the room to encourage student autonomy in their communications with their peers.

Chval, Abell, Pareja, Musikul, and Ritzka (2008) investigated how science and mathematics teachers perceive their professional development experiences as well as what they perceive as their professional development needs. In surveying 1000 of 7150 mathematics and science teachers in Missouri, they received 241 responses. They found that mathematics and science teachers only engage in a small amount of professional development. Only half the teachers in their sample

participated in at least 35 hours of professional development during the previous three years, which amounts to less than one full workweek in development. Furthermore, the teachers reported that the PD they had attended did not fit the description of effective learning environments as described in the *How People Learn* framework. The rural teachers in their sample reported significantly less opportunities to observe or meet with same-subject area teachers. Finally, teachers preferred professional development focused on their subject area and grade level that would provide them with activities relevant to their classroom.

These studies document the range of influence that professional development can have on a teacher as well as the shortcomings in opportunities or initiative among teachers. These studies contribute to my research by providing an empirical basis for the impact professional development can have on a teacher. These studies provide a research basis for the effects of professional development.

Knowledge of Teaching

Knowledge of teaching covers a broad spectrum and includes knowing the culture of the students, knowledge of student cognition, knowledge of content, knowledge of curriculum materials, and knowledge of current trends in research. In this section, I describe some of the research on knowledge of teaching that fall into these subcategories.

Brenner (1998) investigated how mathematical knowledge developed in everyday life and how this knowledge can be used to enhance instruction. Studying the structure of urban and rural Native Hawaiian children, she found that

native children use language particular to their culture when dealing with mathematical concepts. Brenner was able to culturally modify existing curricula that allowed students to more quickly learn the mathematics curriculum as compared to a control classroom that did not incorporate the culturally adjusted mathematics. Knowledge of students' use of mathematics in a cultural context can provide a context for modifying instruction.

Swafford, Jones, and Thornton (1997) investigated the effects of teacher knowledge of student cognition and geometry on teacher instruction by studying 49 middle grade teachers participating in Project LINCS, a 3 year professional development program designed to improve teachers' content knowledge of geometry and knowledge of student cognition. A geometry content knowledge test showed significant gains between the pretest and posttest. More than half of the teachers increased by two van Hiele levels, and 72% increased by at least one level because of Project LINCS. Teachers offered to change lesson plans to a high degree following their participation, including deleting some parts and adding activities. Teachers indicated the need for a pre-assessment for the lessons, and required more verbal and written communication from the students in explaining their work. Finally, teachers with an increased knowledge of geometry and research-based knowledge of student thinking were more likely to spend more time teaching geometry, more willing to try new activities, and were more confident in engaging students in higher levels of geometric thinking.

Smith (2000) reported an analysis of dilemmas that an experienced teacher had in the first year of a mathematics education reform project. In particular, she

looked at experiences that serve as catalysts for these dilemmas and determined which factors offered support in these struggles and that served as avenues for teacher learning. Smith studied one teacher within the QUASAR (Quantitative Understanding: Amplifying Student Achievement and Reasoning) project, analyzing journal entries, videotapes of staff development, and nine interviews with the case study teacher. Smith found three dilemmas: ensuring student success, portfolio assessment, and teacher as facilitator. These dilemmas provided the opportunity for the teacher to revert to previous teaching practices or to change. By reflecting on her own teaching practice and through meetings with colleagues and the research team, she was able to identify areas of teaching that were not in line with reform efforts and modified them to embody these efforts. These alternative efforts for changes in teaching practice came from learning mathematics through experiences with the curriculum, using new curricular materials, reading research on teaching and learning, and interacting with colleagues and research teams.

These studies show some of the categories of knowledge of teaching. Many studies describe the changes teachers undergo when they are increasing their knowledge of teaching. These changes often involve a change in teacher beliefs, whether it is about what teachers think students can learn, or about how curriculum should look. This change in knowledge of teaching sometimes comes through participation in professional development, involvement in a professional community, or personal experience. In the next section, I delve deeper into the influences a teacher's beliefs can have.

Beliefs

Although some of the previous studies incorporate the influences of teacher beliefs, this section is devoted exclusively to the research on teacher beliefs, as they concern instructional practices. In this section, I start with teacher's beliefs concerning the use of technology and end with a study that looks at how curriculum influences teachers' beliefs.

Brown, et al. (2007) analyzed the beliefs of mathematics teachers on calculator use, how often teachers use calculators, and how these beliefs differ by grade bands. Gathering data from 800 teachers in a large city and nearby suburban and rural districts, including 26 high-schools, 29 middle schools, and a random sample of 86 elementary schools the research team found that teachers in all grade bands (elementary, middle, and high school) reported their students used a calculator every day or at least once or twice a week. Four factors were found that accounted for 54% of the variance in the ratings of calculator use. The first factor was Catalyst Beliefs, which indicates that the teacher views the calculator as a tool for better student understanding of mathematics. This factor alone accounted for 30% of the variation in responses. Next was Teacher Knowledge, a factor accounting for 11% of the variance, which describes a teacher's view of their own knowledge of using calculators. The third factor was Crutch Beliefs, a factor accounting for 7% of the variance, which connects to the teachers' beliefs that a calculator allows students to avoid hard mathematical work and that student calculator use inappropriately favors students who make use them. Finally, Teacher Practice was the factor accounting for 6% of the variance and describes

teachers who limited student use of a calculator to checking work, to performing operations already learned with paper and pencil, and for special needs students.

Thompson (1984) studied the relationship between teachers' typical instruction in class and their conceptions of mathematics and teaching to determine how teachers differ by these views. She conducted a case study of three teachers (Jeane, Kay, and Lynn) observing each one for four weeks along with interviews. Jeane's instructional practices were modified primarily on written work turned in by the students. Kay's instructional practices were informed by her constant reflection of her teaching and her perceived view of students' progress. Student difficulties were used to anticipate future problems and lessons were adjusted to account for this. Lynn's instructional practices were dominated by a desire to maintain classroom control and student behavior. This teacher had stated beliefs about teaching and learning that were not seen in her instruction. Other factors affecting her instructional choices were external commitments, disillusionment with teaching, and low expectations for students. Overall, this study demonstrates that teachers hold certain beliefs and views, both conscious and unconscious, which affect how they teach mathematics. With this view of beliefs mediating a teacher's instructional practices, we now look at several other studies related to teacher beliefs.

Guskey (1984) investigated teachers who experience a positive change in their instructional effectiveness to see if they assume greater personal responsibility for the learning outcomes of their students, enjoy teaching more and have positive attitudes toward teaching, and express greater confidence in their

ability to teach (p. 246). He studied 117 middle and high school teachers. Of these 117 teachers, 52 participated in a professional development on mastery learning. Additionally, 44 of the 52 agreed to participate in the experiment of teaching two sections of the same class, where in the experimental class students received the instructional strategy of mastery learning while the control class received instruction as normal. Four groups emerged in his analysis: teachers with a positive change in learning outcomes, teachers with no changes in the learning outcomes, teachers who participated in the training but made no changes, and teachers without the training. Teachers who did not use the new strategies were more likely to have negative attitudes toward teaching but also had higher levels of confidence in their own teaching abilities. This suggests that teachers who are unlikely to change may feel that their style of teaching works best for them and causes them to display negative attitudes toward any change from that style. Teachers who adopted the new teaching strategies tended to accept more responsibility for their students' learning outcomes and had positive attitudes toward teaching. However, these teachers typically expressed low confidence in their teaching skills. Only when teachers saw evidence of positive changes in student learning outcomes did they change their teaching practices.

Deemer (2004) studied the influences of teacher beliefs about theories of intelligence, efficacy in teaching, and school culture on teachers' instructional practices. Her study included 99 high school science teachers in 19 schools in Delaware. These teachers were 91% white, 50% female, and years of teaching experience averaged at 11. Within the classes of these teachers, there were 1680

students of which 64% were white and 19% African-American. She found that higher levels of teacher efficacy predicted the teacher's use of instructional practices that focused on creativity, understanding, and meaningfulness. Furthermore, a school culture of learning and camaraderie influenced teachers to use a master learning approach to teaching. However, teacher beliefs about student intelligence did not account for any variation in teaching practices.

Arbaugh, Lannin, Jones, and Park-Rogers (2006) investigated the influence of a problems-based textbook on teachers' instructional practices, how their practices differ, and what teacher beliefs were associated with these differences. In this study, the authors consider the conceptual framework where textbooks and instructional practices influence each other through the filter of teacher beliefs about learning and instruction. With this framework in mind, they observed and interviewed 26 high school teachers in one district, each teaching at least one course using the Core-Plus curriculum. These teachers participated in two years of professional development focused on using the Core-Plus curriculum. The average teacher experience was 13 years, with a range from new teacher to over 25 years of experience. The findings revealed differences according to the nature of the classroom task, the role of the teacher and social culture of the classroom, the mathematical tools, and equity and accessibility. Of the 26 lessons observed and rated, 11 fell into the low lesson quality category. Initial analysis of the tasks in the curriculum revealed about half required a high level of cognitive demand and half required a low level. Classes in the low quality category frequently involved tasks that were reduced in level of cognitive demand

by the teacher. The teacher's role became one of task simplification, often creating a series of procedures needed for solving problems. The lessons were also taught so that correctness of answers was the focus, rather than justification for the answers. Half of the lessons in this category had instances of student behavior that seemed to influence the teacher's choice to lower the cognitive demand of tasks. Mathematical tools were readily available however, they were generally used to record or calculate and little attempt was made to use them for analysis or comparison. Concerning equity and accessibility, teachers made little to no attempt to connect the problems to the students or allow them to discuss their understanding occurred. The classroom discussions that did occur focused primarily on procedures. The teachers of these lessons reported a belief that students were not equipped to solve problems, due to a lack of basic skills, a lack of understanding, and generally the teachers expressed a lack of faith in students' ability. On the other hand, seven classes of the 26 were classified as falling in the high lesson quality category. All lessons in this category used tasks that required a high level of cognitive demand. The teachers of these lessons encouraged students to find ways to solve problems and to reflect on their processes. Teachers in these lessons still maintained some of the mathematical authority, but not in ways that discouraged student ownership of the mathematical authority. Mathematical tools were available in these classes as well, and were used not only for calculating but also for analysis and comparison. Mathematics was presented as accessible and equitable in these classes as evidenced by students' investigations and explanations of their thinking and reasoning. The teachers of these lessons held

beliefs that the curriculum was appropriate for the students and that it helped develop thinking as well as mathematics. These teachers also expressed concern about students' levels of basic skills, but that these were problems that could be dealt with through the curriculum.

This section has summarized the major factors that contribute to a mathematics teacher's instructional practices. School context factors, professional development activities, knowledge of teaching, and teacher beliefs each play a part in the instructional decisions teachers make. While this section has not provided every possible factor, it provides a research base to the framework of Figure 1 as set forth in Chapter 1. The next, and final, section deals with specific issues concerning the teaching that takes place in mathematics classrooms.

Mathematics Teaching Instructional Practices

This final section presents the studies that support the framework found in Figure 2 in Chapter 1. Figure 2 shows "pedagogy," "content," "lesson design," and "culture" as the primary elements of mathematics teaching instructional practices. In this section, I summarize the types of teaching as described by researchers, which provides a more refined detail of how to view instructional practice. While this section is not easily divided into the sub-sections of pedagogy, content, lesson design, and culture, the following paragraphs describe research and theories that embody these four areas. To help frame the research, Hiebert et al. (1997) provide further structure on how to interpret instructional practices. Their critical features of mathematics classrooms are: 1) the nature of the classroom tasks, 2) the role of the teacher, 3) the social culture of the

classroom, 4) the mathematical tools used to support learning, and 5) equity and accessibility.

Traditional classroom teaching practice in the United States has been found to be consistent throughout the nation (Hiebert et al., 2005). This uniformity has been categorized as “a three-part sequence of teacher initiation, student response and teacher evaluation (IRE)” (Cazden, 1986, p. 436). The classroom instructional practice using IRE requires the teacher to be the primary voice in the classroom with little more than single word or single phrase feedback from the students. When a student provides an incorrect answer, the teacher calls on another student to answer the question until someone provides what the teacher was looking for or the teacher decides to answer the question herself. This teacher role is so pervasive that when Webb and her colleagues (2006) studied seventh graders working in small groups, they found that many of the students exhibited behaviors reflective of the IRE format. While IRE appears to be the primary method of teaching, there are alternatives to IRE that require a different set of behaviors and roles from both the students and the teacher.

Various individuals and organizations have suggested alternative instructional practices. Publications such as *Adding It Up* (Kilpatrick, Swafford, & Findell, 2001) and the *Principles and Standards for School Mathematics* (NCTM, 2000) have suggested ways that teachers can encourage mathematical learning in the classroom. This is a move away from traditional classroom lecture that relies solely on the teacher as the mathematical authority to one that requires students to take an active stance in the learning process. These views of teaching

require educators to consider issues beyond what mathematics to cover, such as choosing which conversations to engage in, which students' views to be heard, and how to provide students opportunities to engage in mathematical conversation in a classroom setting. However, these theories on teaching and learning leave one wondering what the research on teaching suggests.

In an effort to make sense of the discrepancies between documented practices and suggestions for teaching, Hiebert and Grouws (2007) summarized the literature on practices that yielded gains in student achievement. They concluded that, regardless of teaching style employed, the effective classrooms were those that 1) focused on becoming efficient in executing skills and 2) those that develop conceptual understanding. Delving deeper into conceptual understanding, Hiebert and Grouws identified two sub-categories: 1) teachers and students attending explicitly to mathematical concepts and 2) students struggling with important mathematics. There are many ways teachers can address these two areas in their instructional practices.

In terms of instructional practice, one of the teacher's roles is that of task selection, a component of the design of a lesson. Franke, Kazemi, and Battey (2007) describe four developmental areas of classrooms, one of which is task selection. As well described in the QUASAR project, tasks have several implementations as they move from how they were written, to how the teacher implements them, and eventually how the students treat them. A teacher's role in the selection and treatment of tasks is important, especially as students begin

asking questions and asking for assistance (Stein & Lane, 1996). The choosing of and implementation of tasks is part of bridging lesson planning with pedagogy.

Following task selection and implementation, effective instructional practices should incorporate classroom discourse about mathematical ideas. A teacher must make the details of the conversation explicit, both in what is expected from the students in terms of content and respect for others' ideas. Lampert (2001) suggests three activities that foster mathematical discourse. The first is to identify, through discourse, the aspects of a problem that will validate proposed solution strategies. Next, the discourse should focus on conjectures on how the problem could be solved. Following the conjectures, the class or group should revise conjectures and focus on legitimate and promising avenues for solving. This must be done in a manner that respects the views and conjectures that are abandoned in favor of others. Teachers must establish these three aspects of mathematical discourse with the goal that the students can do this with limited teacher intervention.

Furthermore, the teacher must create a conversational structure that will produce student learning. Several researchers have conducted studies describing how teachers do this. For instance, King (1992) described a method of instruction for high school and college students where students are responsible for asking and answering questions based on the higher levels of Bloom's taxonomy. Peterson (1981) studied large and small group instructional formats on fourth and fifth grade students learning geometry. Peterson found that high-achieving and low-achieving students benefited from the peer interaction that was allowed by the

small group format. Although classroom discourse has been found beneficial for many groups of students, Webb, Nemer, and Ing (2006) studied seventh graders working in small groups and found that within the groups the students emulated the role of a traditional teaching style complete with the “teacher” doing most of the work and asking low-level questions. They suggest that teachers working to implement small group norms model appropriate teacher behaviors and that teachers monitor the interactions of students while working in groups.

Creating a classroom rich in discourse, whether in mathematics or any subject, requires a deep understanding of classroom conversations. Franke, Kazemi, and Battey (2007) described developmental areas of classroom conversations that can further a teacher’s efforts to ensure equity and accessibility. The use of *revoicing*, that is, the act of the teacher repeating statements made by students allows teachers to position students with low or minor social status into an elevated state (O’Connor & Michaels, 1993). It also allows teachers to emphasize or validate thoughts and ideas as put forth by the students. In this way, the teacher’s role is to emphasize ideas that will lead to fruitful conversations. Teachers must know their mathematics well enough to make wise decisions in directing conversations this way. Teaching and learning mathematics requires thought, depth of investigation, and the ability to communicate findings by both the teacher and the students, suggesting a need for developing a suitable classroom culture.

Doing mathematics in this way contrasts greatly with the typical norms of a traditional mathematics classroom. As early as first grade, students report that

mathematics requires quick answers and particular strategies for finding answers (Franke & Carey, 1996). This presents a challenge to educators at all levels as this sort of view of mathematics continues throughout the K-12 experience. This view of doing mathematics has led to a special area of research focusing on social norms in the mathematics classroom, called sociomathematical norms. As social norms have been studied in general, research of mathematics classrooms has yielded norms that are specific to mathematics education. Here I provide a theoretical piece on these norms along with research documenting their effects.

Kilpatrick, Swafford, and Findell (2001) suggest four norms for sociomathematical development 1) value ideas and methods for solving problems, 2) students must be autonomous in their conjectures, choices of solution, and presentation of solutions, 3) developing mutual respect for others' ideas and conjectures, even those that do not work out, and 4) the locus of authority must reside outside of the textbook, teacher, or social status of the person making the argument. They suggest that the mathematical authority of the solution must reside in the reasonableness and sensibility of the solution. Yackel and Cobb (1996) showed that providing classroom interactions that required students to be autonomous in their learning of mathematics provided them with the tools, dispositions, and beliefs that form the basis of empowerment to be autonomous citizens, outside of the classroom, when utilizing mathematics.

This concludes my review of the literature review for my study. Following the frameworks I described in Chapter 1, in this chapter I have reviewed the literature on alternative certification at large, the factors that researchers have

shown to impact instructional practices, and the types of instructional practices that are prevalent or documented in the research literature. In the next chapter, I describe how I conducted my study. Chapter 4 provides the analysis of what I found, and the final chapter provides the findings and future directions for research.

CHAPTER 3: DESIGN AND METHODS

This study employed qualitative analyses to address and answer the research questions. In the following sections, I describe my research design, including the data collection methods and instrumentation, my participants and associated demographics, and my procedure for data analysis.

Research Design

In order to answer the research questions, I analyzed data collected in a three-year longitudinal study of alternatively certified mathematics and science teachers. Since my study is a subset of a larger study, I will first describe the overall purpose and context of the larger study.

The National Science Foundation (grant # 0335523) funded a study of the alternative certification programs in Missouri. This study employed Program Theory Evaluation to investigate the processes and outcomes of alternative teacher certification in Missouri. Assumed outcomes of these programs were: alleviation of teacher shortages, production of qualified teachers, increased teacher retention, increased underrepresented groups in teaching, and improved quality of student learning.

Initially, the 117 mathematics and science teachers were split into six groups to be observed and interviewed by the research team. Both mathematics and science teachers were assigned to each member of the research team. The teachers were contacted several weeks in advance to schedule a time for observation, and once scheduled, a survey was mailed to the teacher approximately one week in advance. Typically, time was planned for the

interview to take place immediately following the observation. All teachers were visited once per school year. During the 2004-05 school year, most observations took place in the spring. During the 2005-06 school year, most observations also took place in the winter and spring. For the 2006-07 school year, all observations took place in the fall of 2006.

Data Collection

The larger Alternative Teacher Certification Program study included four data collection tools. One component was a teacher survey, used to evaluate the teachers' perceptions of their programs and their current support from the school in which they were currently teaching. A second instrument was the Classroom Observation Protocol instrument modified from Horizon Research, Inc. (Horizon Research Inc., 2000). Along with these, a third instrument was a classroom observation narrative constructed by members of the research team. This observational narrative was designed to further support the Classroom Observation Protocol by providing details as to what was observed during the classroom observation. A fourth component was a post-observation interview in which the research team interviewed the teachers.

To investigate my research questions, I analyzed data from the classroom observations and the post observation interviews. As my study is qualitative in nature and contains a small sample, I omitted the use of the survey. I describe the remaining sources in detail below.

Observations. Classroom observation data consisted of two data sources: (a) a structured observation protocol (Horizon Research Inc., 2000), and (b) field

note observations. The classroom observation protocol provided a basis for assigning a quantitative value to the teaching practices employed during the scheduled observation. The protocol was adapted from one developed by the researchers at Horizon Research, Inc. (Horizon Research Inc., 2000) and focused on four areas: lesson design, pedagogy/implementation, content, and culture. A fifth, “summary” category provides a rating of the overall lesson in relation to standards-based instruction. My use of the data gathered with this protocol aligned with others’ use of this instrument in mathematics education research (c.f. Arbaugh, Lannin, Jones, & Park-Rogers, 2006).

Each area of the protocol was scored from 1 to 5 with ‘1’ being indicative of “not at all reflective of best practice in mathematics/science education” and a ‘5’ representing “extremely reflective of best practice in mathematics/science education.” In order to establish our reliability, the research team discussed these ratings in weekly meetings throughout the data collection period. The “lesson plan” section considered the aspects of the teacher’s lesson design. Some aspects included planning for various learning styles, helping students see where this lesson fits in the larger picture, providing time for summarizing, and utilizing resources that support instruction. The “pedagogy/implementation” section focused on various aspects of teaching such as teacher questioning techniques, teacher confidence in teaching, encouraging students to collaborate, relating content to the lives of students, the pace of the lesson, the management of the classroom, and appropriate activities. The “content” section was used to document the appropriateness of the content for the lesson, whether or not the content was

standards-based, making connections to other areas of the same subject as well as relating to other subject areas, and the teacher's accurate presentation of the subject. The "culture" section included aspects such as active student participation and engagement in the lesson, the teacher and students valuing this engagement, a climate of respect for student ideas and participation, a collaborative relationship between students while working on the assignment, a climate conducive to critical thought and questioning of concepts that is academically rigorous. A final overall score was assigned to each observed lesson. In all five sections, the observer considered the entire list of aspects and assigned a score, from 1 to 5.

Each observation also had associated field notes of the observed lesson. These written field notes emphasized the four areas found in the observation protocol and provided details to the quantitative measure and the perspective of the lesson from someone observing the classroom. Field note documents averaged 2-5 pages in length. A blank template is provided in Appendix A. These narratives provide the primary data for exploring questions about the teacher's instructional practices as well as changes in their practices over time.

Interviews. Each observation was followed by an interview of the teacher's perspective on the lesson's strengths and weaknesses as well as expected student misconceptions, the teacher's assessment practices, and the teacher's use of local, state, and national standards in planning the lesson (see Appendices B, C, and D). Teachers were also asked about the support found in their school including that of administration, other teachers in and out of subject

area, and assigned mentors. Interview data were instrumental in exploring and analyzing factors that influence changes in the teachers' instructional practices.

Participants

Within the larger study, the data set revealed 51 mathematics teachers in eight universities (for details on the five largest universities, see Heinen & Scribner, 2005). These 51 teachers were composed of people who had not taught previously and were all working on certification in mathematics.

For my study, I analyzed data from the mathematics teachers in the data set that taught during school years 2004-07. Of these 51 teachers, 25 taught mathematics for the three consecutive school years from 2004-07. This set of 25 teachers offered a unique look at a group of beginning alternatively certified teachers as they progressed through the first three years in the profession. These 25 teachers served as the participants for my study.

I used an identity code of letters and numbers for teacher identification and used this designation throughout my analysis. The letter represents an alternative certification program, and the number is for the individual teacher. These 25 teachers included 18 female teachers and 7 male teachers representing eight different Alternative Teacher Certification Programs (ATCPs) in the state of Missouri. Table 1 shows this information, their age, ethnicity, and career data. All teachers were white (coded 6) except B5, G1, and G2, which were African-American (coded 4) and F4 who was from Europe and thus was coded as "other" (coded 7). This table also provides information on their education and their most recent career. Notice that eight of the teachers had no prior career and went

straight into an ATCP following their undergraduate studies. This table provides the characteristic information as commonly reported in several of the studies outlined in Chapter 2. I now further describe how these teachers were analyzed.

Table 1

Teacher characteristics

Teacher ID	Gender	Age	Ethnicity	Highest degree earned	No. of previous careers	Most recent career
A1	F	43	6	B.S. Business	2	Homemaker
B1	F	52	6	B.S. Recreation	unknown	
B2	F	33	6	B.A. Business Administration	4	Marketing Database Contractor
B3	M	34	6	B.S. Agriculture	3	Water district supervisor
B4	F	25	4	B.S. Computer Science/ Mathematics	0	
B5	F	40	6	B.A. Anthropology	2	Anthropology
B6	M	25	6	B.S. Mathematics/ Computer Science	0	
B7	M	42	6	B.A. Electronics & Electricity	1	Computer Tech
B8	M	33	6	B.A. Aviation	3	Aviation pilot
C1	F	34	6	B.S. Mathematics	3	Substitute teacher
C2	M	22	6	B.S. Mathematics	0	
D1	F	52	6	B.A. Accounting	3	Bookkeeper
D2	F	39	6	B.A. Accounting	1	Accounting Office
E1	F	37	6	B.S. Mathematics/ Computer Information Science	3	Homemaker
E2	F	24	6	B.A. Mathematics	0	
E3	F	55	6	B.S. Mechanical Engineering	6	Engineering assistant
E4	F	40	6	B.S. Economics	2	Economist
E5	F	25	6	B.A. Music	0	
F1	F	50	6	B.A. Chemistry/Electrical Engineering	3	Substitute teacher
F2	M	25	6	B.S. Mechanical Engineering	0	
F3	F	26	6	B.A. Religious Studies	0	
F4	M	61	7	M.A. Art	7	Structural steel detailer
G1	F	51	4	B.A. Business Administration	1	Finance
G2	F	26	4	B.S. Computer Science	0	
H1	F	45	6	M.A. Architecture	3	Architect

School and Classroom Demographics

The next series of tables document the schools the participants were teaching in as well as demographic details of the observed classes. Table 2 provides the urban/rural designation for each of the schools as designated by the National Center for Educational Statistics (NCES). The NCES provides this information for public schools, but not private schools. Teacher F1 taught in a private religious school.

The school classifications in Table 2 are from the National Center for Educational Statistics. The codes are as follows:

1. Large City -- Central city of a Consolidated Metropolitan Statistical Area (CMSA) or Metropolitan Statistical Area (MSA) with population of 250,000 or more.
2. Mid-size City -- Central city of a CMS or MSA but not designated as a large central city.
3. Urban fringe of large city -- Place within the CMSA or MSA of a large central city.
4. Urban fringe of a mid-size city -- Place within the CMSA or MSA of a mid-size central city.
5. Large Town -- Place not within a CMSA or MSA but with a population of 25,000 or more and defined as urban.
6. Small Town -- Place not within a CMSA or MSA with a population of at least 2,500 but less than 25,000.

7. Rural, outside MSA -- Place not within a CMSA or MSA and designated as rural.

8. Rural, inside MSA -- Place within a CMSA or MSA designated as rural.

Table 2

School classification by National Center for Educational Statistics

Teacher ID	School classification		
	Observation 1	Observation 2	Observation 3
A1	8	8	8
B1	7	7*	7
B2	3	3	3
B3	7	7	7
B4	1	1	1
B5	1	1	1
B6	7	8*	8
B7	7	7	7
B8	7	7	7
C1	8	8	8
C2	8	8	8
D1	7	7	7
D2	7	7	7
E1	4	4	4
E2	3	3	3
E3	7	7	7
E4	8	8	8
E5	7	7	4*
F1	private	private	private
F2	8	8*	8
F3	8	8*	8
F4	8	8	8
G1	1	1	3*
G2	3	3	1*
H1	1	1	1

* indicates change in school building from previous year

Tables 3, 4, and 5 each provide details of the classes in their respective observations. Along with the teacher’s identification, this table provides the grade level of the course observed, the title of the course, and the total number of students, with male and female numbers when available. Blank cells represent data that was not collected, and the first observation has the highest incidence of missing data.

Table 3

Student grade, course name, and gender for first observation

Teacher ID	Grade	Course	M	F	Total
A1	8	CMP Moving Straight Ahead			
B1	8	Mathematics	9	11	20
B2	8	8th Grade Math			
B3	9 to 11	Consumer & Business Math	9	2	11
B4	10 to 12	Pre-Calculus	4	14	18
B5	7	Pre-Algebra	6	12	18
B6	9 & 10	Mathematics	5	12	17
B7	9	Applied Math	4	2	6
B8	8	8th Grade Math	4	7	11
C1	11	Algebra II	3	4	7
C2		Algebra II	12	6	18
D1	6	Developmental Math	4	4	8
D2		Jr. High Math	10	8	18
E1	7 & 8	Algebra I	8	13	21
E2	10	Algebra I	8	10	18
E3		*			
E4	9	Algebra I	4	12	16
E5	11 & 12	Algebra II	7	6	13
F1	7	Mathematics	8	6	14
F2	7	Algebra I			22
F3	7	7 th grade math			25
F4	12	Statistics			23
G1	6	6 th grade math	8	9	17
G2	10	Math Academy	8	6	14
H1	7	7 th grade math	10	12	22

* not a mathematics class

Table 4

Student grade, course name, and gender for second observation

Teacher ID	Grade	Course	M	F	Total
A1	8	CMP Moving Straight Ahead	11	12	22
B1	6	General Math	10	9	19
B2	8	8th Grade Math	10	14	24
B3	7	Pre-Algebra	14	11	25
B4	10 to 12	Pre-Calculus	7	11	18
B5	8	Pre-Algebra	10	6	16
B6	10	Algebra II	10	15	25
B7	8	8th Grade Pre-Algebra	4	4	8
B8	8	8th Grade Pre-Algebra	4	3	7
C1	11	Algebra II	3	6	9
C2	10	Algebra II	11	4	15
D1	6	Developmental Math	4	3	7
D2	8	Jr. High Math	8	9	17
E1	9	Pre-Algebra	9	10	19
E2	10	Algebra I	9	11	20
E3	10 to 12	Algebra II	1	3	4
E4	10	Geometry	2	11	13
E5	11 & 12	Algebra II	7	12	19
F1	7	Mathematics	3	2	5
F2	10 to 12	Algebra II	2	5	7
F3	10 to 12	Geometry	7	7	14
F4	11 & 12	Statistics	18	9	27
G1	6	6 th Grade Math	13	9	22
G2	9 to 11	Math Academy	9	3	12
H1	7	Pre-Algebra	8	8	16

Table 5

Student grade, course name, and gender for third observation

Teacher ID	Grade	Course	M	F	Total
A1	8	Integrated Algebra	10	6	16
B1	8	8th Grade Math	12	11	23
B2	8	8th Grade Math	10	14	24
B3	7	7th Grade Math	11	4	15
B4	10 to 12	Pre-Calculus	5	14	19
B5	8	Pre-Algebra	8	12	20
B6	10 & 11	Algebra II	11	6	17
B7	9	Algebra I	4	3	7
B8	7	7th grade math	6	11	17
C1	10 to 12	Algebra II	4	8	12
C2	9 to 11	Applied Math	6	6	12
D1	8	8th Grade Math	6	3	9
D2	9 to 12	Pre-Algebra	3	3	6
E1	9 to 11	Applied Algebra	5	4	9
E2	9 & 10	Algebra I	10	9	19
E3	10	Geometry	1	3	4
E4	11	Algebra II	3	7	10
E5	10 & 11	Algebra II	3	8	11
F1	6	6th grade math	4	3	7
F2	10 to 12	Algebra II	4	7	11
F3	10	Geometry	8	3	11
F4	12	Statistics	14	21	35
G1	6	6th grade math	6	6	12
G2	7	Middle School Math	0	7	7
H1	7	7th grade math	5	10	15

Data Analysis

To study instructional practices among these teachers, I placed them into categories based on their observed instructional practices over the three-year data collection period (Yin, 1994). Yin (1993) stated that “teaching practice” makes an excellent unit for analysis in educational research (p. 33). In this study, I employed this unit of analysis to instructional practice over time. To study these

units, I used open and axial coding to investigate the data (Strauss & Corbin, 1990). Field notes from observations and interviews from the 25 mathematics teachers served as my primary data source. Other data sources, such as demographic information on the teachers and their classrooms, were used to inform the analysis. These data sources allow me to address Yin's (1994) recommendation to use "multiple sources of evidence...converging on the same set of facts or findings" (p. 78). In the following paragraphs, I detail the analysis to provide specific details on how I documented beginning instructional practices and how they changed over the first three years.

To investigate the teachers' instructional practices, I first analyzed all 25 teachers' first year lessons. This analysis revealed a variety of practices, and provided a baseline from which to determine future changes. Analysis of the first year's data allowed the creation of categories based on teaching style, e.g. lecture, IRE, group work. I then described these categories in detail by creating vignettes of the lessons according to the framework for classroom observation, found in Figure 1. As I investigated the teachers' lessons over time, I looked for a way to classify these changes or lack of changes in instructional practice. Four categories of change emerged, and to document the types of changes and the factors involved, I chose individual teachers from these categories to serve as case studies (Yin, 1994). In these cases, I detailed the lessons taught each year, again according to the framework for teacher observation found in Figure 1. I then provided a within-case analysis of each case study teacher to try and specify the changes and what factors may have contributed to these changes.

Since I did not employ pure grounded theory, I drew on the qualitative methodology called issue-focused analysis (Weiss, 1994). This analysis is similar to grounded theory as described by Strauss and Corbin (1990) and consists of four parts: coding, sorting, local integration, and inclusive integration. These four areas provide additional theory on open and axial coding without going so far as to arrive at a grounded theory. In the following four paragraphs, I define these terms of issue-focused analysis.

Coding is the process of reading through the observational narratives and interviews and identifying overarching themes within them. For instance, a theme of “primary instructional practice” emerged from the data. This level of coding is similar to “open coding” as described by Strauss and Corbin (1990). When particular themes become common among many teachers the process of sorting begins.

Sorting is the process by which codes are arranged into topics and subtopics. In this study, I sorted teachers according to various instructional practices they had in common for their first year instructional practices. When the data from all three years were considered, new groups were created to account for a second theme of “change over time.” When the sorting process within these groups reached an end, the next phase of issue-focused analysis began.

Local integration is the process of taking the sorted codes and beginning to put together sections of findings and developing “minitheories” (Weiss, 1994, p. 159). During this phase of analysis, the sorted codes produced topics and subtopics that produced reportable findings.

Finally, inclusive integration is the process of tying together commonalities, differences, and any other miscellaneous findings to make sense of all the data. To extend the analysis, I employed the constant-comparative method of questioning the data and making comparisons throughout the analysis. In this way, I maintained “theoretical sensitivity” and allow the data to speak for itself (Strauss & Corbin, 1990).

Contextual factors found in Figure 1, such as school setting and school support, were identified within the interviews and observational field notes. Instructional practices were analyzed through coding the observational narratives, such as an IRE or non-IRE teaching style from the discussion about Figure 2. Looking at both field notes and interviews, an understanding of the roles of the teacher and students was evident, as was the culture of the classroom. Strauss and Corbin (1990) suggest caution about using concepts found within the literature, as biases may be introduced that are not supported by the raw data (p. 69). With this caution in mind, I watched for factors associated with changes in instructional practice that were unique and only arose within the data.

Example of coding process for interviews

Once the case study teachers were identified, I read through the interviews to gain a complete picture of each teacher. Of the four case study teachers, only two of the twelve potential interviews were missing. Figure 3 displays a sample of the coding processed used to analyze the interview data. Similar analysis was used for all four of the case study teachers. Some of the initial codes included: experience, instructional practices, standards, mentoring, certification program support, and career. The codes

were organized into the general categories of certification program, professional development, school context, knowledge of teaching, beliefs, and support structures.

Example of coding process for lesson observations

Figure 4 displays a sample of the coding used for the lesson fieldnotes. Here is an excerpt of coding from the Implementation/Pedagogy section of a lesson (see appendix A). To the right is the overall coding of the lesson, in this case IRE. To the left are sub-codes that indicate the classroom interaction as well as the instructional focus. Primary instructional practices arose from the data. Examples are lecture, IRE, station work, and group work. Some categories were combined, such as station work and group work. Furthermore, I stayed sensitive to the data, and as a result, a new coding category in instructional practice arose during the third year's observation: whole-class discussion.

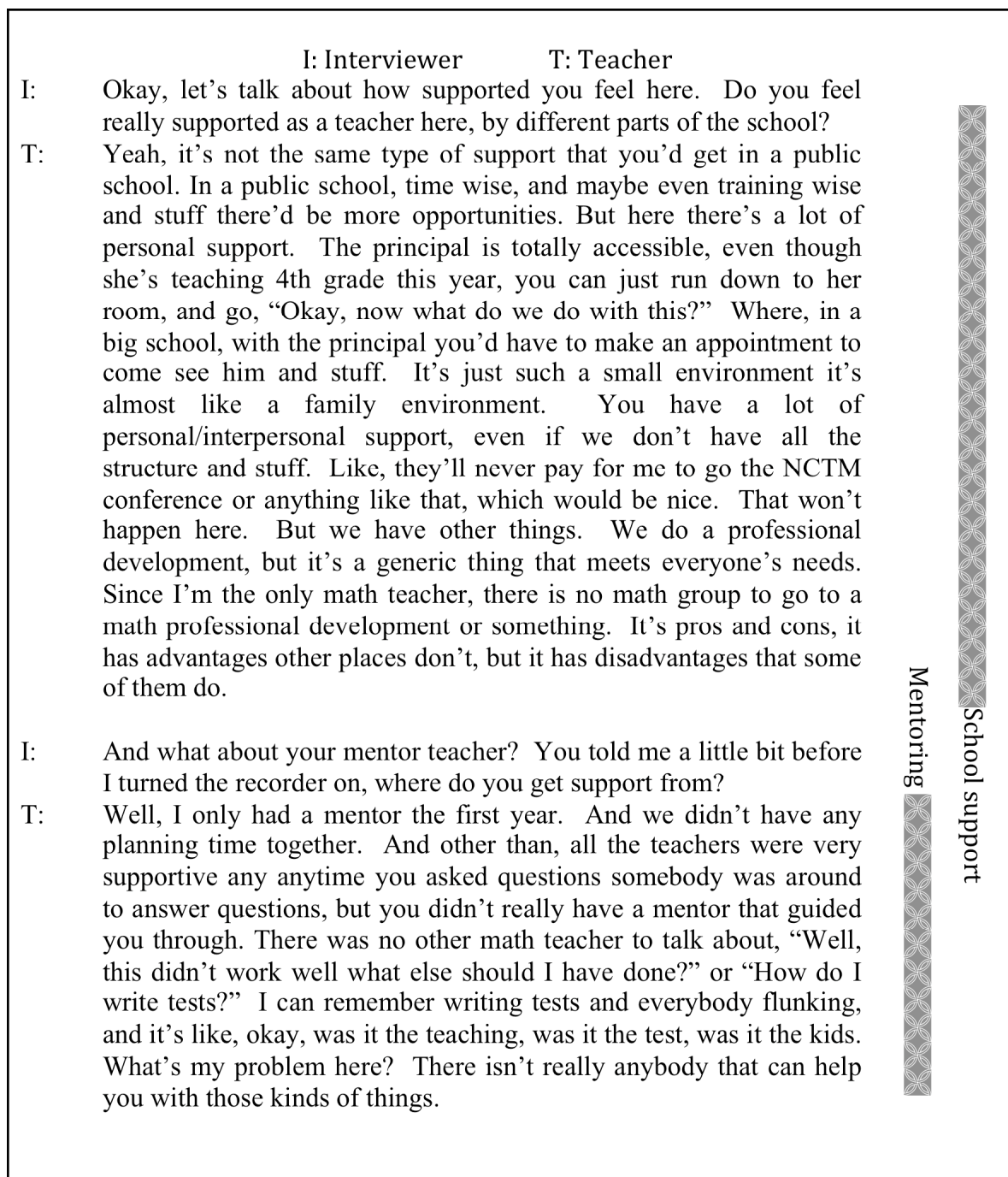


Figure 3. Sample of the coding process used to analyze the teacher interview data.

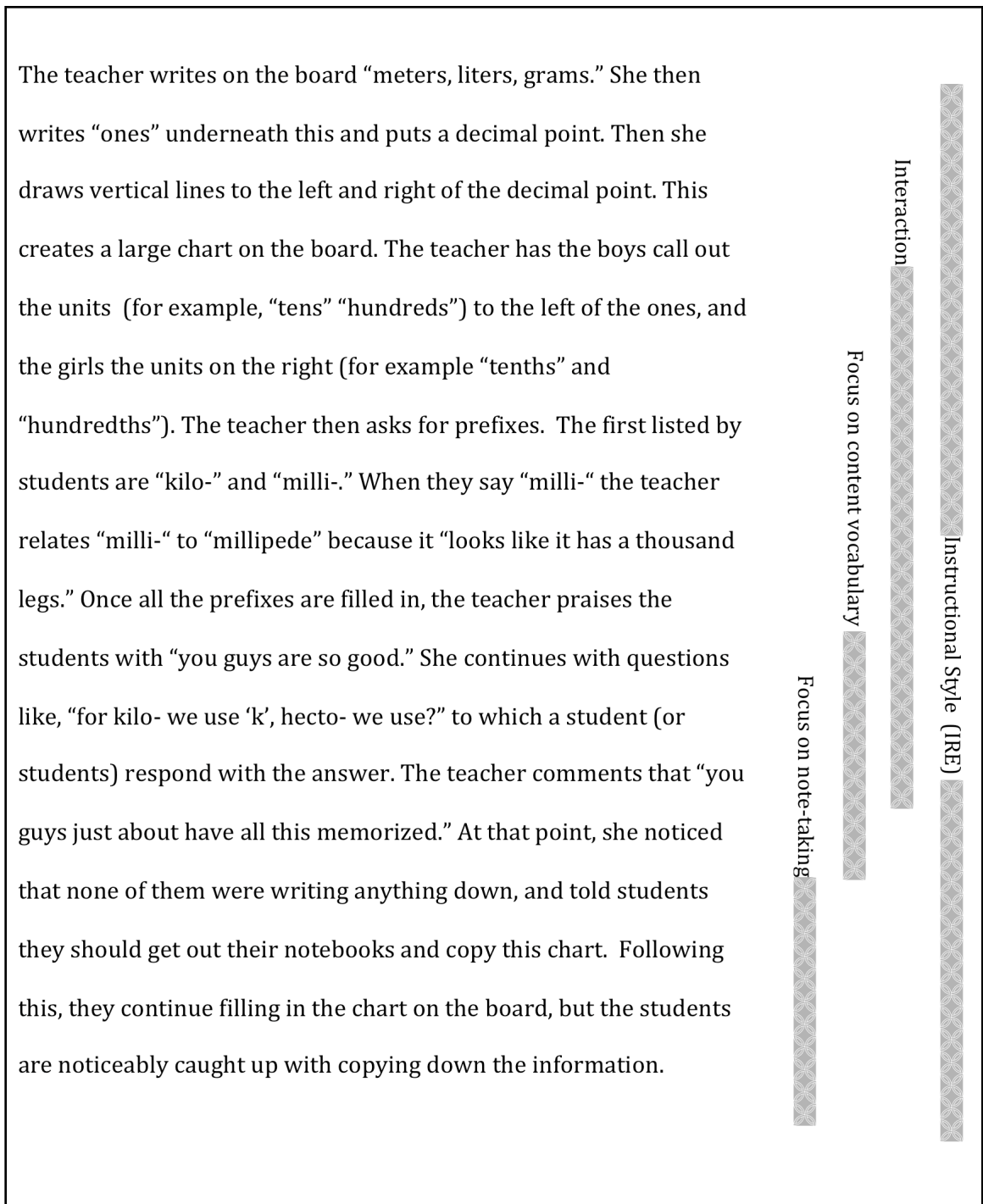


Figure 4. Sample of the coding process used to analyze observational fieldnotes.

CHAPTER 4: FINDINGS

This chapter contains two minor sections followed by three major sections. I begin with a one minor section describing the teachers, including data about their Horizon Observation quantitative scores for the first year. The second minor section includes the summary scores for the three years observations. Following these, the first major section is *Instructional Practices of Beginning Alternatively Certified Mathematics Teachers* and it contains the analysis of all 25 teachers during their first year of teaching. The second is *Changes in Instructional Practices* and provides the analysis on how these teachers taught over the three-year study. The final section is *Associated Contextual Factors of the Case Study Teachers* and documents data collected in the interviews that contributed in part to the instructional practices of the teachers.

Teachers Who Were Studied

What instructional practices do beginning alternatively certified mathematics teachers employ? To begin answering this question, I analyzed the data of the 25 teachers from eight university programs. Eighteen of the teachers were female, and seven were male. Table 6 shows the Teacher, Subject taught, Gender of the teacher, and the five scores the teachers were assigned by the observers based on the single observation during the first year using the Classroom Observation Synthesis Protocol.

Table 6

First year classroom observation protocol scores

Teacher ID	Subject	Lesson Design	Pedagogy	Content	Classroom Culture	Summary
A1	math	3	3	3	3	3
B1	math	3	3	2	3	3
B2	math	3	3	3	3	3
B3	math	4	4	4	3	3
B4	math	3	3	3	5	3
B5	math	3	3	4	4	3
B6	math	1	1	1	2	1
B7	math	4	5	4	4	4
B8	math	3	3	5	3	2
C1	math	2	2	2	2	2
C2	math	1	1	2	2	1
D1	math	2	2	2	2	2
D2	math	3	3	3	2	3
E1	math	4	4	3	4	3
E2	math	3	2	4	2	2
E3	neither	n/a	n/a	n/a	4	3
E4	math	3	4	3	3	3
E5	math	2	2	1	2	1
F1	math	4	4	5	5	4
F2	math	2	2	2	1	2
F3	math	3	4	4	5	4
F4	math	3	3	4	4	4
G1	math	4	3	2	3	3
G2	math	4	4	4	5	4
H1	math	4	4	4	3	4

The summary column in Table 6 lists the overall scores for each of the teachers.

Figure 5 shows the frequency of these scores. Three teachers scored a “1” in the summary category the first year, with five teachers scoring a “2,” 11 scoring a “3,” and six scoring a “4.”

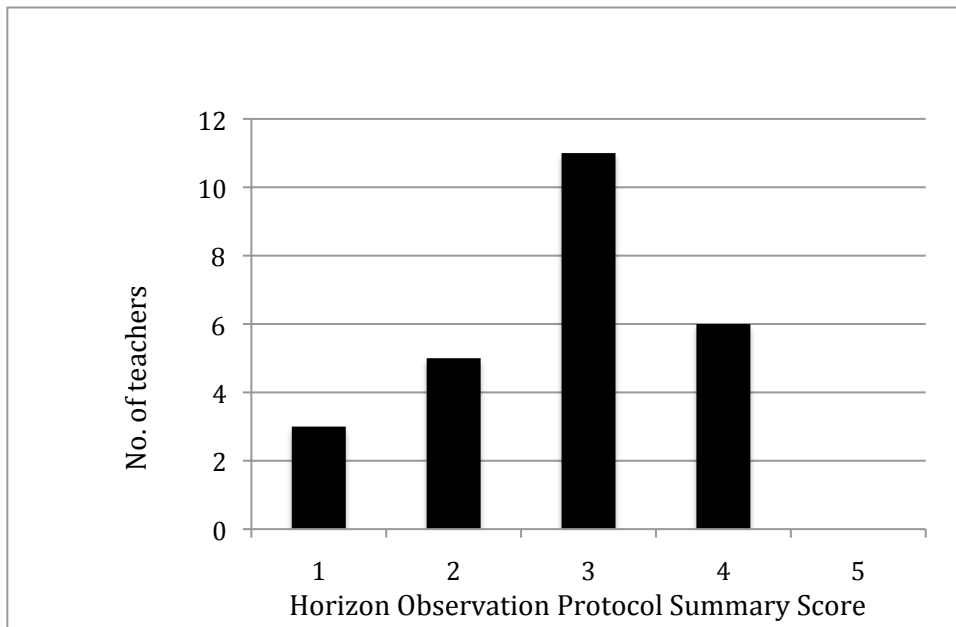


Figure 5. Frequency of summary scores in first year observations.

Of the 25 teachers, 22 scored in the range from 2 to 4. None of the teachers were scored as a “5,” that is, “extremely reflective of best practice in mathematics/science education.” However, three teachers scored a “1,” which is “not at all reflective of best practice in mathematics/science education.” These classes do not provide students with the planning, teaching, content, or culture for meaningful learning to occur. An important thing to keep in mind is that these teachers will go on to teach for two more years. Let us look now at how these teachers fared for the full three years.

Teachers over Time

This section documents the changes in summary scores on the Horizon Classroom Observation Protocol over the three observations. To begin to answer, “How do the instructional practices of alternatively certified mathematics teachers change over the first three years of their teaching?” I investigated further into the Classroom Observation Scores of the 25 teachers over three years. Table 7 shows the summary scores for the 25

teachers over the three-year study. Figures 6 and 7 show the totals for the summary scores for the second and third year observations.

Table 7

Three years of classroom observation protocol summary scores

Teacher ID	Summary Score		
	Year 1	Year 2	Year 3
A1	3	3	3
B1	3	2	2
B2	3	3	3
B3	3	3	3
B4	3	3	3
B5	3	2	1
B6	1	3	2
B7	4	3	1
B8	2	2	3
C1	2	3	4
C2	1	2	1
D1	2	2	2
D2	3	2	3
E1	3	3	4
E2	2	3	1
E3*	3	4	2
E4	3	3	4
E5	1	1	2
F1	4	1	1
F2	2	2	4
F3	4	3	1
F4	4	3	4
G1	3	1	2
G2	4	3	2
H1	4	4	5

*teacher was assigned a non-mathematics classroom in year 1

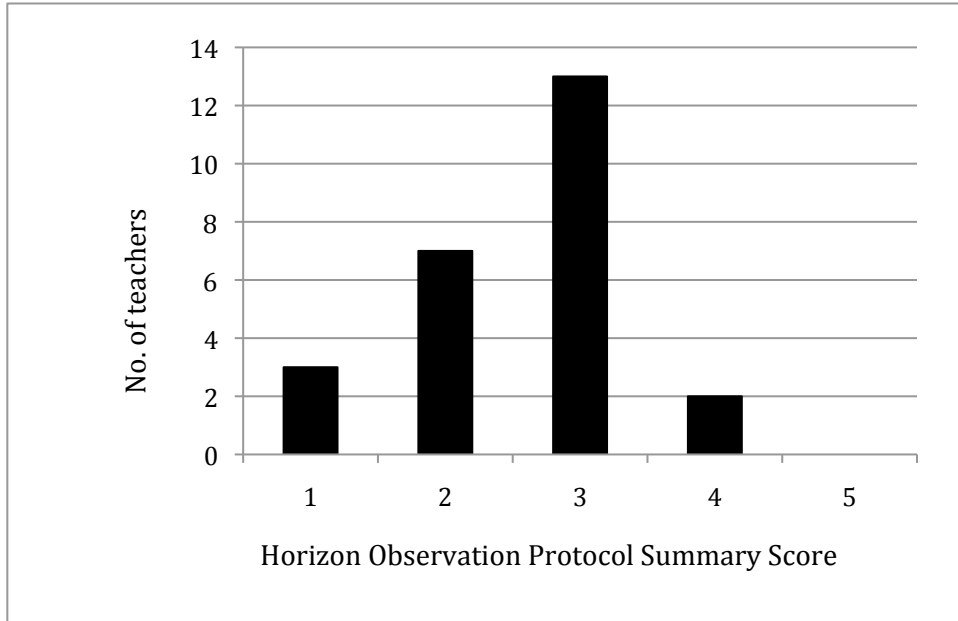


Figure 6. Frequency of summary scores in second year observations.

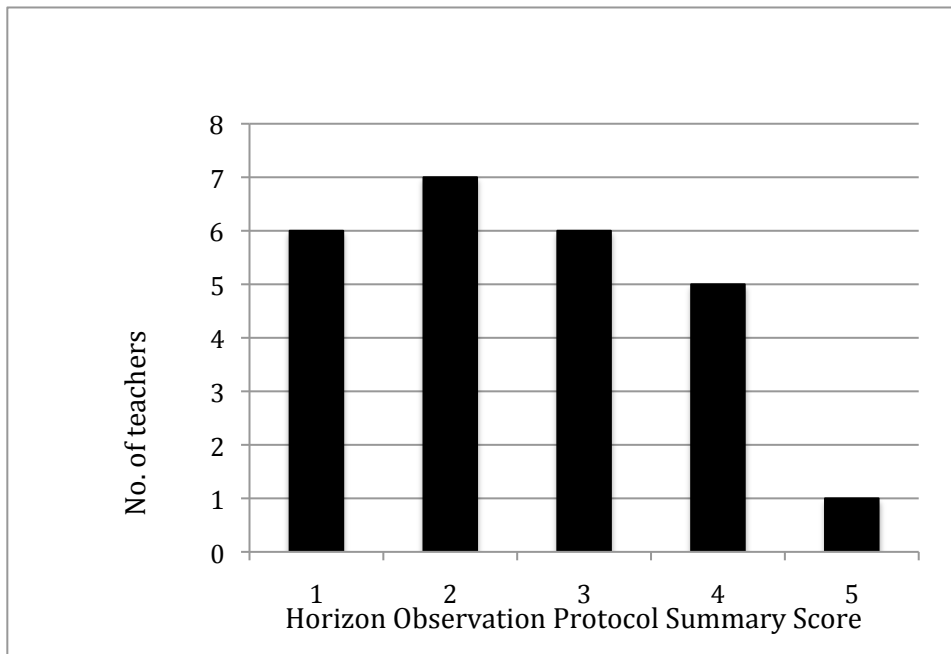


Figure 7. Frequency of summary scores in third year observations.

While summary scores from the observation instrument are informative, they do not provide the detail needed to answer my research questions. In the next section, I

characterize the instructional practices of these teachers as viewed through the observational field notes that were written to accompany the scores above.

Instructional Practices of Beginning Alternatively Certified Mathematics Teachers

The 25 teachers' lessons from the first year of observation were sorted into categories based on the instructional practices employed. The analysis revealed five distinct practices: IRE, Station Work, Student Presentations, Lecture, and Individual Work of two varieties: Teacher-designed and Computer-designed Curriculum. In the following paragraphs, I describe the five instructional practices.

IRE stands for “teacher-*initiated* question, student *response*, and teacher *evaluation*” (Cazden, 1986; Franke, Kazemi, & Battey, 2007, p. 231). IRE has typified the back-and-forth banter seen in U.S. classrooms for several decades. Typically, the teacher asked questions with one-word or short-phrase responses, often requiring students to utter the answer to a particular calculation (e.g., Teacher: What is the complement of 53° ? Student: 37° . And then the teacher affirms or corrects the response). Nine lessons fell into this category, with an average Horizon Classroom Observation Protocol Summary score of 2.9.

Station/Group Work was used to designate a teaching practice in which students worked in groups on exercises or problems located at stations within the classroom while the teacher circulated through the room gauging student understanding and offering help where needed. Two lessons were in this category, with an average Horizon Classroom Observation Protocol Summary score of 3.5.

Student Presentations was an instructional practice in which students present mathematical information, either individually or in groups, to their classmates. This

differs from Station/Group Work category in that the mathematical focus was on the presentations of the students. Two lessons were categorized as Student Presentations, with an average Horizon Classroom Observation Protocol Summary score of 2.

Lecture was a pedagogy in which the teacher presented information to students, often accompanied with examples. Lecture differed from IRE in that the students were not verbally engaged in the lecture. Five lessons were placed in the Lecture category, with an average Horizon Classroom Observation Protocol Summary score of 2.4.

Individual Work occurred in two distinct ways. One lesson required students to work individually on exercises or problems the teacher created, and the teacher served as the only human resource when students encountered mathematical difficulties. One other lesson was placed in the second variant of this category, Computer-based Curriculum, in which students also worked individually at their own pace, solely on the computer. The teacher's role was to make sure students were working and to tutor them individually if they were unable to complete a unit on the computer. Two lessons fell into this category with an average Horizon Classroom Observation Protocol Summary score of 4.

The first year lessons, categorized by dominant mode of instruction, have been compiled in table 8.

Table 8

Instructional practices of beginning alternatively certified teachers

IRE	Station Work/ Group Work	Student Presentations	Lecture	Individual Work Curriculum Teacher Created	Unable to Determine
B2, B4, B8, C2, D1, E1, F3, F4, H1	B5, F1	B1, E5	C1, D2, E2, E4, F2	B7 G2	A1, B3, B6, G1

In the following analysis, I provide a representative vignette of each of the identified instructional styles. I begin with IRE, which has been termed as “traditional teaching” by some researchers (Franke, Kazemi, & Battey, 2007). These vignettes illustrate the types of instructional practices that beginning alternatively certified mathematics employ.

IRE lesson

This section summarizes the instructional practices of the teachers who used an IRE instructional style. Many teachers modified the IRE approach by allowing time for students to work, either individually or in groups, and then to report progress to the

teacher. In the following vignette, I focus on a teacher who used group work modification, although I briefly describe another lesson in the summary for consideration.

Vignette 1

This lesson involved 24 students in an eighth grade mathematics class in a small town not far from a major urban area. The lesson focused on collecting and representing data, including some emphasis on conversions of fractions and decimals. With this in mind, I explored the observed class according to the framework.

Pedagogy

The teacher began the lesson by having the students indicate which pizza they liked best. She listed on the board: Pepperoni, Cheese, Canadian Bacon, and Sausage. As the teacher called out the name of a type of pizza, the students raised their hands to indicate if that was their favorite type. Once her students had the pizza types and the votes finalized, they individually recorded this information on their work sheets and worked in groups to figure out what percentage of the class liked each of the different types of pizza best (teacher B2, observation, February 2005).

This lesson incorporated IRE instruction with some small group work. A typical example of what the teacher wrote on the board: 0.25 of 360 degrees. She asked the students why she wrote 360 degrees. One of them replied, “There are 360 degrees in a circle.” The teacher then asked, “What do we do when we hear the word ‘of?’” Another student replied, “multiply.” The teacher then wrote on the board: 0.25×360 degrees. She asked the students what 0.25×360 equaled. The students used their calculators and replied, “90 degrees” (observation, February 2005). Once the teacher was done with her explanation, she had the students return to their work in groups.

As the students worked in groups, the teacher stopped at one group and asked, “Did your group have a discussion? OK, tell me your thoughts.” The students explained how they were using the percentages to divide a pie graph to represent the types of pizza and student preference of those types (teacher B2, observation, February 2005).

The teacher connected converting percents with different ways of representing data. The students used percentages to interpret data about student preferences between four different types of pizza. The goal was to represent this as a pie graph (observation, February 2005).

Her lesson concluded with a summary of the lesson. The teacher asked students about what they learned, emphasizing that students should explain their reasoning for the processes that they followed. At the end of class the teacher asked each group that finished the assignment to write in 20 words or less what they learned in class today. She noted, “I don’t want a list” (observation, February 2005).

Content

The lesson was collecting data, converting it to a percent, and using the percent to create a pie chart representing the data collected (teacher B2, observation, February 2005). The teacher attempted to present mathematics as a means of making sense of the world. The teacher began the lesson by collecting student data on pizza preference by voting (observation, February 2005).

Some opportunities to deepen student understanding of percents and fractions were missed in the computational focus. For example, when the teacher discussed how to deal with 25%, she asked what 0.25 of 360 degrees was. However, she did not relate the fractional portion that 0.25 represents to the whole of the circle. The students used their calculators to compute the answer. The teacher allowed the students to go back to group

work once they had established 90 degrees to be the answer (observation, February 2005). Throughout the period, there was no relation of 0.25 and a quarter of a circle, or similar connections with familiar fractions to ease calculation and make sense of these representations.

The teacher did connect various areas of mathematics as well as other subjects by incorporating protractor use and data representation with additional practice working with percentages, all of which were based in the data they collected as a class (observation, February 2005).

Design of the Lesson

This lesson involved review of previous concepts and provided some application of mathematics. The teacher noted that many students were struggling with percent-related problems, so she provided activities that revisited this content. She said,

But we've been actually talking about percents this week. How to be given a percent and how to find a value, given a value, how to find a percent and different kinds of problems. It confused a lot of the kids. When do I multiply and when do I divide? And so, I've taught those that were confused to set a proportion to find that out. (interview, March 2005)

She was concerned about these difficulties, and was looking to allow students to incorporate their previous skills. Students had been working with percents and needed more practice.

The teacher also mentioned the need to work with protractors to prepare for the state MAP test. Once she found this lesson, she reflected,

I haven't really stressed (using a protractor) in the eighth grade because, I thought, 'we're in eighth grade we know how to use a protractor'. And with the MAP test

coming I thought, 'this is great because it incorporates our percents and our proportions plus you get that practice using a protractor.' (interview, March 2005)

The teacher referenced state standards on occasion, but did not connect the state standards to the main activities in her lesson. The state standards were summarized on a blue sheet of paper. These standards existed prior to the new state Grade Level Expectations. She said,

Well, I have the blue sheet when I'm doing all the lesson plans. I can't say that if you asked me to write all the standards down I would get all of them. But, I do take my blue sheet out occasionally. I do not do it for every lesson. I have been through my GLE's, Grade Level Expectations. And I know what those are inside and outside. And, so then what I try and do with those is work my standards in.

But I don't look at the standards before each lesson. (interview, March 2005)

The teacher comments above demonstrate how she takes into consideration the past experiences the students have and tries to keep old topics that are difficult from becoming tedious.

Culture of the Classroom

The classroom culture shifted from teacher-led discussion to group work and back again without difficulty. For example: When the teacher noticed more than one group having the same difficulty, she stopped the entire class and had a discussion about the difficulty. Then she allowed them to go back to group work (observation, February 2005).

The classroom culture was conducive to learning and working with mathematics. Student group work time was noisy but conversations were on topic. These students were encouraged to work collaboratively with the teacher as well as each other. There was a

lively, collegial atmosphere in this class as seen during the class data collection of pizza preferences. The students offered ideas and worked together productively with each other within their groups as well as during the IRE interaction with the teacher (observation, February 2005).

Most of the public mathematical discourse occurred with student small groups; whole group discourse consisted of the teacher asking questions that required simple calculations.

Summary of the Lesson

As this vignette shows, this classroom offered students a chance to connect multiple areas of mathematics, interact with one another, and engage the teacher in mathematical discussions. The teacher provided practice with skills related to percents and decimals through the context of representing data.

Another teacher also used IRE as her instructional format to teach a lesson on finding ordered triples using Gaussian elimination. Her lesson differed than the vignette because it involved students in individual class work when she was not interacting with them in the IRE process. Another difference was her focus on developing deeper student understanding. For instance, she made sure that various solutions that students arrived at were displayed. One example problem the teacher put on the board:

$$x - 2y - z = -5$$

$$2x + y + z = 5$$

Students worked quietly and most appeared engaged. The teacher waited for them and then called on a student. Student: “Zero, zero, five.” The teacher wrote “(0, 0, 5)” on the board and asked “Anyone else?” Another student: “I got one. 4/5, -12/5, 1.” Another student: “-1, -3, 10”. She asked students for their answers and did not stop asking until

she had these three distinct, yet equivalent, answers (teacher B4, observation, May 2005). She then discussed with the class the concept of infinitely many answers.

In general, these IRE lessons took place in classrooms where the focus was on learning. Tasks were designed that required students to work, individually or in groups, and then share answers with the teacher. Classroom management distractions were minimal in the observations, and the teachers revealed a concern for students to understand the mathematics involved.

Station Work/Group Work Lessons

Station work lessons were characterized by an instructional practice in which students traversed a series of “stations” that contained an activity for a group of students to do for a designated time period. Groups rotated to each station. The teacher’s role was to supervise the students and provide assistance when necessary. Group Work lessons are similar in that students work in groups but do not traverse to various stations. Typically, the teacher assigned each group a task that they completed wherever they were located. In the following vignette, I present the lesson observed in which students rotated between stations in groups. This vignette describes the only Station Work lesson observed.

Vignette 2

This lesson occurred in pre-algebra class in an urban district. The class consisted of 18 students in a 7th grade pre-algebra class. The teacher described students in this excerpt from the interview below,

The one thing that that class does have in common is that they’re all really good at math, or they have demonstrated somewhere that they are good at math. And they’re mature too. They’re the most mature of all four of my classes. (teacher B5, interview, February 2005)

The lesson involved a group work activity investigating how the area of a circle could be derived. The teacher had set up several stations that presented situations in which students could investigate various ways to find the area of a circle.

Content

The class started with “bell work” that was a review of prior learning and not connected to the rest of the lesson. The bell work questions asked students to “change the following sentences to math sentences using numbers, letters, and math symbols” (observation, February 2005). These questions allowed students to review previously learned material and provide time for the teacher time to perform various administrative tasks. However, these problems were unrelated to the main lesson of the day.

The main portion of the lesson involved the use of several stations that were designed for students to develop the formula for the area of a circle. The area of a circle at each station was determined with a different method using various models. At one table, students folded a circle to make several triangular shapes. They then had to make these triangular pieces form a sort of parallelogram. Another table had students use a scale to weigh fabric that was cut from a circle and balance it with square units of fabric. In this way, they were to estimate how many squares of fabric were needed to weigh the same as the fabric circle (observation, February 2005).

Each station contained a circle. Each station’s circle was the same size at all of the stations. In this way, the teacher provided the opportunity for students to see mathematics as multi-faceted and allowed students to recognize that the methods for area derivation may vary, but the results remained unchanged (observation, February 2005). Students at stations were working on various ways to think about circle area, the radius of a circle,

and the relationship between the area of a circle and the area of a square. The models were geared to conceptual thinking and sense making.

Pedagogy

The lesson began with about 30 minutes of bell work with students working on previous content that was unrelated to the eventual lesson on areas of circles. Once the teacher gave the instructions for groups and stations, the students proceeded to work at various stations for about an hour.

The main lesson structure involved dividing students into several groups to transverse the seven stations during the period. The teacher used stations with the same size circle to help them understand that all methods for finding area resulted in the same quantity. She stated,

It was the same circle [at each station]. And they're supposed to derive the formula for the area of a circle. When they get enough of the stations done, we're hoping that they see a pattern. That to divide the area by pi, that they'll get 36 every time. (interview, February 2005)

The focus was on one of several processes for finding the area of a circle, with a different procedure at each station (observation, February 2005).

Design of the Lesson

In planning the lesson, the teacher anticipated student difficulty with vocabulary and concepts, as well as a new instructional method. She said, "I want them to get used to station work. And we're at the point where they're kind of mad at me because I'm not giving them the answers. So I'm trying to get them to be self initiating" (interview, February 2005). She continued, "Well, I knew that they were going to have trouble with the area of a square, or remembering that we'd done it already and what area is"

(interview, February 2005). Despite her recognizance of student trouble with area of squares, she did not use the bell work period of class to review the concept of area.

Culture of the Classroom

The culture of this classroom was characterized as passive disobedience. Students were generally unfocused and disengaged. A result of this was that activities took too long and at any given time, half the students were off task. As a result, management issues dominated the culture of this classroom.

The classroom atmosphere did not allow students to focus on the mathematical content. Thirty minutes was provided for the bell work problems, and after 10 minutes the teacher read aloud the directions for the bell work activity. It was obvious that the students had not read the instructions on the overhead prior to the teacher's reading of the instructions. During the bell work time, about half the students were on task and working, and about half were off-task. By the end of the bell work period, most students were off task. The teacher had to raise her voice to bring them back to attention (observation, February 2005).

Another example was during the station work when the teacher asked a student where his paper was. He responded that he did not have his paper. The teacher moved to another group without further addressing this situation. A final instance was that although the teacher moved around the class, there were two groups she never communicated with during the station work (observation, February 2005).

Although the tasks were well structured and the teacher had classroom management strategies, she could not maintain order and learning simultaneously (observation, February 2005).

Summary of the Lesson

Although this lesson involved an innovative approach to teaching area of circles, the teacher demonstrated difficulty with the management skills necessary to maximize the learning opportunities for all students. Furthermore, the bell work time was drawn out more than necessary, leading to disruptive behavior.

Student Presentations

Two lessons used an instructional style involving student presentations. Below I present a vignette to illustrate the instructional practice as viewed through the framework for classroom observations.

Vignette 3

This algebra 2 lesson occurred in a rural school district. Thirteen students in 11th and 12th grade were in this classroom. The lesson covered multi-digit multiplication and division, an elementary school level of content, and occurred toward the end of the school year. The classroom teacher described the academic aptitude of the class as, “Middle to high. Definitely not low; this would be an elective that they would only chose if they were going to college” (teacher E5, interview, May 2005).

Pedagogy

The lesson consisted of presentations by various student groups. While student presentation can be an effective instructional strategy, the activity in this class period did not exemplify meaningful learning, as indicated by the Horizon Protocol score of ‘1’. The interactions between students and between the teacher and students focused on procedural aspects of algorithms for multi-digit multiplication and division (observation, May 2005). The teacher asked each group of presenters to include “key points,” including showing a strategy to check your work, show your work, and individually check your answers (observation, May 2005). An example of key points by one group involved

multiplying the divisor by the result when performing long division (observation, May 2005). During this time, the teacher sat in the front of the room with the majority of the students behind her, scoring each group according to a scoring guide.

Design of the Lesson

This lesson was designed to allow student groups to lead class and teach their peers mathematical objectives. The teacher stated in the interview,

The purpose of it was, well, (after MAP) testing it gets a little So what I do is a teaching project with them and it makes them break down something that they really should know that they have probably forgotten. And then by them breaking it down, they internalize it better, and then they teach it to us so that we get that review also. A little bit of both. It's like it's own unit, it's after MAP, this is what we do, I have them start this project and we do it until the end of the year.

(interview, May 2005)

The teacher stated that reviewing procedures was what occurred “until the end of the year,” demonstrating that such a focus represented a considerable portion of her instruction. When asked what difficulties she expected of the students, she noted,

I knew that this pair was going to have trouble because the lesson that they turned into me to grade was not adequate. So, I gave them suggestions for them to change and they didn't do what they needed to do to get them changed. So, I was pretty sure that they were not going to be prepared. So, as for the students, it's hard for them to get up there up and talk to us like they're the teacher. Oh, I knew that they would have a hard time teaching and being in charge. And the kids have a hard time letting them be in charge also. So, it's still, it's hard to avoid that peer-to-peer relationship in that, but I added as part of their scoring guide that

professionalism counted for a good part of their grade, so as long as they weren't goofing around, joking, trying to be class clowns, then they would be okay. And so I prepared for that in the scoring guide, because I knew that that would be an issue. (interview, May 2005)

Her focus on difficulties seemed to be primarily on the challenges associated with managing the class, having students be the “teacher,” and acting professionally. She did not indicate any concern over the mathematical content that she assigned students to present.

Content

In the lesson, the students in this algebra 2 class demonstrated how to perform elementary level arithmetic operations to their teacher and classmates. One group presented on multi-digit multiplication, another on long division (observation, May 2005). Neither the teacher nor the students made any effort to connect the mathematics in the lesson with the content that would be appropriate for high school students in an algebra 2 course. The interactions among students and between the teacher and students focused on following a procedure without connections to meaning (observation, May 2005). Neither the student presenters nor the teacher explained the underlying ideas for their procedures or explain the relationship between multiplication and division (observation, May 2005). The teacher noted below that she was aware of the state standards, but did not connect those to this particular lesson.

I've been trying to focus on the GLE's now, since they're going to change how the testing is done. So I've tried to stick to what they would want to have in each grade. But I'm kind of in transition with that. It depends on the subject, but as I get to the higher level, juniors and seniors—I have a math analysis class, pre-

calculus class—I try to teach them the skill that they’re going to need to take math courses in college. That’s what they really need from me at that point. I still try to do the grade level expectations, but there are some things that are not on there that they’re going to need to know for college, college algebra-type stuff. (interview, May 2005)

The teacher noted that she focused on materials that prepared students for college mathematics courses, but provided no such connection to the content of the observed lesson.

Culture of the Classroom

The teacher demonstrated positive rapport with students and the relationship was mutually respectful. However, the nature of the mathematical work and classroom discussions focused on low-level mathematics. During student presentations, the teacher did not question students about the underlying mathematical ideas that supported and did not connect the mathematical activity to the content appropriate to algebra 2 (observation, May 2005). The students presenting obviously worked together, but the rest of the students worked individually. The teacher sat in the front row of desks, with most of the students behind her (observation, May 2005).

Summary of the Lesson

Within this lesson, there was a potentially innovative instructional format that was novel to her students. However, the focus of the lesson was not on the mathematics involved, nor the connection of the mathematics presented to any other grade-level appropriate mathematics. The teacher served mostly as an evaluator, not as a mediator of content. The other students in the class did not engage in the mathematics in the

presentation. One other lesson involved this sort of instructional practice, although it was more connected to grade-appropriate mathematics.

Another lesson in the category of Student Presentations was an 8th grade lesson in a rural district focused on deepening student understanding of pi. The teacher said,

They went to the computers and first did their own research on pi, what pi is, how to calculate pi, and what the history is. And so, through their own investigation they're going to be able to tell me what Pi is. We are going to celebrate pi day by having small groups of my students, 8th graders, going into K-7th grade classrooms to teach the meaning of pi, maybe a little history of pi, and then they conduct maybe an activity or two, they may read a story. One group is doing a puppet show of *Sir Cumference and the Dragon of Pi*. (teacher B1, interview, March 2005)

Of the seven student groups, some shared facts about pi that were correct and others shared facts that were incorrect. For example, one group explained to the teacher and the class how to find pi using this formula: divide the diameter by 2 multiply that by 3.14 and multiply by 2. This group described how they planned to have their K-7 “students” measure the diameter of M&M cookies and figure out what pi was by using the formula above and then letting the kids eat the cookie. Although the teacher did not address this misunderstanding at the time, after another group presented wrong information, the teacher pointed out their mistakes.

Unlike the other Student Presentation lesson, the content these students worked on was appropriate. However, the students lacked supervision on the content while they did

their research. In this lesson, too much unsupervised time while planning their lessons for the K-7 “students” resulted in a lesson that did not arrive at its full potential.

Lecture

A second group of lessons were observed where the dominant instructional practice was characterized as a lecture. Lecturing differs from the IRE style described in the literature in the sense that there is little to no dialogue with students. Lecturing is best described as a teacher sharing information while the students listen. Five lessons were observed where the teacher employed a lecture style instructional practice. I present one vignette as an example. The following vignette typifies what was seen in the other teachers’ classrooms. In the summary of this section, I note a few differences that demonstrate some variation in the lecture format.

Vignette 4

This lesson occurred in a junior high mathematics class of 18 eighth grade students in a rural school with 8 female and 10 male. The observation occurred in the spring. The lesson focused on solving problems involving distance, rate, and time. This lesson occurred within a chapter on ratio, proportion, and percents.

Pedagogy

The teacher employed a lecture style of teaching. Bellwork was on the board for students to work on upon entry. The teacher designated one student to go to the board to show his work for the bellwork problem (teacher D2, observation, April 2005). To begin her lesson, she had a student read a textbook problem aloud. The teacher wrote on the board “ $d = r * t$ ” without any further explanation. After writing the equation the teacher asked, “At that rate how long will it take to travel 231km? With the mileage what do we need to do next?” None of the students raised their hands to answer. She continued to fill

in information and then solved the problem. Other examples she worked required the formula $d=rt$ to have values input to be solved for a missing value, others required a proportion and cross-multiplication (observation, April 2005). These problems required that the students be able to discern what type of problem this was (i.e. $d=r*t$, proportion, etc) and then the formula that went with that type of problem and then which facts belonged with the symbols. The students watched and listened during the lecture without taking notes or other involvement (observation, April 2005). One exception to this absence of dialogue occurred on an example she worked out involving a proportion. “Is there a shortcut for this one?” asked the teacher, referring to the first step in solving a proportion. “No,” replied the students in unison. “What do we do if we have no shortcut?” Students in unison again, “Cross-multiply.” There was no discussion of what “shortcut” she was referring to, but the students seemed quite familiar with this type of situation and the teacher’s question.

Following the lecture, the teacher distributed a worksheet for students to work on individually (observation, April 2005). She then walked around and helped students individually as they worked on the worksheet (observation, April 2005).

Design of the Lesson

The teacher had bell work on a white board for the students to do first thing when they entered the room. She collected homework and then had a student go to the board to show how he worked out the bell work problem. She then began a lecture using some problems from the students’ math text and worked those out on the board while the students watched. Finally, she had the students work on a work sheet for the rest of the class time as she walked around giving individual help.

Content

The teacher worked examples in a way that certain formulas would solve certain situations and no other considerations came up (observation, April 2005). For example, the student read the opening problem and the teacher immediately wrote the formula on the board that fit the problem. In this way, mathematics seemed to be presented as a series of routine procedures. For instance, twice students responded with a rehearsed response that indicated that certain skills were emphasized in this classroom. When the teacher finished one problem, she moved onto the next without waiting for questions or having the students work out any practice problems at their seats, suggesting that these exercises were self-explanatory.

Culture of the Classroom

There was little interaction in this classroom but the teacher commanded the respect of the students. For instance, she only asked for their attention once and they remained quiet for the rest of class (observation, April 2005). The limited interaction between the teacher and students that did occur seemed rehearsed, as seen in the unison responses on the proportion example. At other times, the teacher asked questions and no students responded or raised their hands (observation, April 2005). These rehearsed phrases were the only words spoken by the students during the observation (observation, April 2005). No collaboration occurred among students. All work was individual, and students asked the teacher for assistance while working on problems after the lecture (observation, April 2005).

Summary of the Lesson

This lesson represents the instructional practices of the five teachers who used this instructional practice. Teacher E4 also utilized this practice while teaching a lesson on

factoring to a group of tenth grade students in algebra 1, but had some interesting comments on the choice of using a lecture. The teacher stated,

Often times you just don't want to deal with that resistance to it [lecturing]. And I don't know why. I don't know if it is how they have just gone through school. When I try to get them to do a hands-on lesson, they are like, 'Can't you just show us how to do it?' (teacher E4, interview, May 2005)

The core features of the lecture lessons were that the teachers provided the exclusive source of mathematical thinking. They frequently used rhetorical questions, and saved student questions for a time of individual work following the lecture.

Individual Work Lessons

In the first year of observations, two lessons were observed in which students worked individually for the majority of the class period and the teacher did not spend any time using any instructional format. The first vignette contains the lesson where the teacher's role was to create a lesson that students worked on independently and then circulated to help students on an individual basis. The second vignette describes a classroom where the teacher's role was to monitor students working independently on a computer-generated curriculum.

Vignette 5 Teacher Created Curriculum

This vignette presents a lesson that occurred in a rural ninth grade class. This class comprised six students with learning disability (LD) and behavior disorder (BD) individual education plans (IEPs). Some students were 17 years old and were still classified as freshmen. The lesson involved practicing arithmetic with integers.

Content

The teacher presented integer addition and subtraction as part of everyday life. The observer commented, “It was clear that many of the students were at the functional limits of their abilities. Several times the teacher had to model writing checks, even though a few students claimed they had checking accounts” (teacher B7, observation, October 2005).

The mathematical content involved personal finances. It took students considerable time to master the underlying procedures of writing a negotiable check (e.g., writing the check amount in both numbers and words), transferring the check amount to the checking register, and completing the appropriate calculation (observation, October 2005).

Pedagogy

The teacher employed a non-traditional format. Students were involved in a practicing a task individually. Students spent their time determining the various values of a checking account. The teacher has created a problem packet that would overdraft their checking account. In the interview he said, “Well, I put little hiccups in there that will catch them, and I’ll find out tomorrow. So they’ll have to go back there and rebalance it and check out the checks” (interview, October 2005).

The teacher spent previous class periods on the topic of integer operations and continued this lesson on an application to improve fluency. He said,

Last week we dealt with negative and positive numbers. Which are, I mean, you deal with them on a number line. We started off last week adding and subtracting, multiplying and dividing integers. And this week we’re actually going to apply integers. (interview, October 2005)

The teacher used a checkbook with debits and deposits to allow the students to work with the concept of integers. He said,

What I was noticed was that a lot of students were just writing out the checks and they weren't balancing it. And of course, I find it a lot of times appalling. If you give them instructions the students don't do it. They'll say, well, here I'm going to do it this quick way and I'm going to go back and balance it. Well, I put little hiccups in there that will catch them, and I'll find out tomorrow. So they'll have to go back there and rebalance it and check out the checks. (interview, October 2005)

Throughout the lesson, the students worked on their problems and the teacher moved around the room checking on students and answering any questions that came up.

Design of the Lesson

The teacher expressed concern over this group of special education students in 9th grade, and how they work below grade level. He said, "What I'm trying to do within our curriculum, and of course with [the state] standards, is dealing with integers which is basically a 6th-7th grade concept. These students have not got it yet on a lot of things" (interview, October 2005).

Here the teacher admitted to the realities of teaching a group of students who performed below grade level. He considered how this lesson fits with previously covered material. He said,

We did a little exercise with a tape measure last week, with the number line. It fits in with our school curriculum, but at the same time it's no where near where it needs to be, but I have to deal with the students that I have. (interview, October 2005)

Despite the level of the content, he related the topic to financial aspects of adult life. He went on to say, “The only value that they can see in learning something is something like a checking account” (interview, October 2005).

In preparing this lesson, he utilized a state web resource that correlated with state standards. He used content that is from lower grade levels to fit the students he teaches. He stated, “I actually pulled this lesson off of the [state web resource site] and then I custom fit it. I realize that this is for 6th-8th grade, but these are low-end students” (interview, October 2005).

He expected trouble with the very concept he was teaching, especially when presented in an abstracted sense, such as using a number line. He said,

If I put up something like $-5 - 5$ it's hard for them to see that $-5 - 5$ is -10 , it's hard for them. Or if I wrote it up there as $-5 + -5$, it's hard for them to see that those two expressions are the exact same thing. Basically what's happened is they have not learned number sense. (interview, October 2005)

Culture of the Classroom

Although the students were willing to do the course work it seemed that some were not engaged. For instance, students were eating candy and talking of off topic subjects to each other as they worked. The teacher accommodated these students by insisting that they complete their work and ignoring the off task activities the students engaged in (observation, October 2005).

The teacher negotiated these possible distractions to learning. Initially some students protested and complained, but the teacher avoided engaging in the arguments. When presented with the task, several students objected, saying “I'll never get a checking account,” and protested having to work at all. The teacher ignored these complaints and

worked to keep students on task, often discussing the process and arithmetic of adding negative numbers with individual students (observation, October 2005). Students eventually saw the relevance of the activity, and much of the resulting whole class discussion that occurred while they were working was about checking accounts, individual student finances, and bill paying. Although students worked individually, the small size of the class allowed group discussions to be whole-class discussions.

Summary of the Lesson

This teacher was able to negotiate student complaints and kept them on task. By spending substantial time, the teacher was able to customize the lesson to meet the students on a content level they could handle, personalize the lesson so that it was relevant to their lives, and incorporate state standards. Furthermore, he monitored the students as they worked, minimizing distractions. By monitoring the students as they worked, the Individual Work lesson kept students on task throughout the period.

Vignette 6 Computer-Created Curriculum

Only one observation occurred where the instructional practice was entirely computer-based. The instructional practices in this lesson were different than in a traditional classroom. The teacher served primarily as a supervisor while students were working independently and tutored students when necessary.

This vignette describes the teacher who supervised students in a “math lab” intended to emphasize algebra skills and provide remediation in basic arithmetic skills. This was a class of 10th grade students, both black and white, containing eight males and six females in a class called “Math Academy.” The computers gave reports about student progress. The teacher said,

If students don't master concepts, then we can either do a small group instruction, I can pair them with a buddy if there's another person in the class that's from the same module, or usually I just do individual tutoring with them." (teacher G2, interview, November 2004)

The teacher stated that she was able to work with students needing help. However, during our observation this was not seen. The framework for classroom observation provided less information than in other lessons, but the interview provided further insight.

Content

Content was tailored to individuals by the computer programs. Topics included 150 basic math objectives in Accelerated Math and 13 chapters in Cognitive Tutor. The teacher indicated that these were set up so that "they're successful to be prepared for geometry next year" (interview, November 2004).

Design of the Lesson

The computer program used for instruction decides what each student will be working on based on their past performance. The teacher stated, "The computer just keeps generating them new questions" (interview, November 2004). The teacher made decisions based on the computer's analysis.

The students experienced their curriculum by computer, and topics were covered until they are mastered. "If they mastered a topic, then they test out of it in a regular unit test that I would print for them" (interview, November 2004).

The teacher referred to both state-level assessment and standards. She said, "Standards play a big role because of the fact that we were seeing that our kids were not prepared for the MAP their tenth grade year, our district decided to put every freshman, regardless of where they were at their eighth grade year or their seventh grade year, in

algebra. From algebra, they were going to move directly into geometry because you see algebra and geometry on your tenth grade MAP. Because of that, we went through and we realigned all of our GLE's to make sure that they were hitting every benchmark in the grade that they needed to hit it to be prepared for the MAP test their sophomore year.”

(interview, November 2004)

Pedagogy

The computer instruction was independent of the teacher's decisions. The focus seemed to be solely on solutions. “

For the computer assessment, I have to actually print out of a book and give it to them. The test uses scan-trons and that's done by the computer. Students just bubble in the scan-tron and it scans and then the computer automatically generates their new practice [exercises]. (interview, November 2004)

The teacher did not allow calculators. She said, “Their math algebra teachers were saying that my students were dividing on their own because they knew how to do it now, while the others were using their calculators. I just thought that was great.” Concerning the computer curriculum, she expresses how the students are able to work at their own pace and receive results quickly. “The cognitive tutor – they love it because if they don't do well, the computer just keeps generating them new questions. The Accelerated Math, I know that sometimes they get frustrated with. Because they get their results right after they scan, they're able to see if I got 100 or if I got an 80 or not. We're usually able to talk about it and say, ‘Okay, you did this right, you didn't do this right, you understand this, you do not understand this.’ They love the instant gratification and I believe it's effective because their other algebra teachers are saying ‘this is like a big thing for me

because there's no calculators in my classroom.' Part of that was because we believe that the kids need to have the basics. Students need to know that four times four is sixteen."

Culture of the Classroom

The course was new and early in the school year the teacher had to battle a negative stereotype of the course. She described this,

At the beginning of the year, we struggled with being a new program. It was piloted this year for the entire district. A lot of the kids at the beginning thought that this was for special education, so I had to go over the fact that none of the kids in the class were classified as special education. In fact, I can't have anybody with an IEP or a 504 plan in my course. So we have to really break down that barrier, and then we also have to discuss this understanding that somebody may struggle here and somebody may struggle there doesn't mean that one of you guys have learned and the others haven't because you're both struggling. So, we have to go through that a lot, but that's the only negative stereotype. I think a lot of kids want to get in to the class, but because of the number size requirement, they can't get in because we cannot exceed fifteen kids." (interview, November 2004)

Summary of the Lesson

This observation took place in what seemed to be more of a study hall than a regular classroom. The teacher had no control over this aspect. During the observation students were working and on task and there was no communication or disruption. As far as the observation framework covers, this class period was nearly absent of instructional practices.

Summary of Instructional Practices

My analysis revealed five distinct practices in the first year observations: IRE, Station Work, Student Presentations, Lecture, and Individual Work of two varieties: Teacher-designed and Computer-designed Curriculum. There were four lessons with insufficient data to determine instructional practice and one teacher assigned to a non-mathematics classroom, and I excluded those lessons from the analysis of first year lessons. The following table shows the instructional practices and which teachers taught them for the remaining 20 teachers.

In my analysis of the first year data, nine of the 20 teachers employed IRE. This accounts for 45% of the observed lessons. Another five of the 20 teachers employed lecture, accounting for 25% of the observed lessons. Viewed together, 14 of the 20 lessons, or 70% of the lessons, were taught using two instructional styles.

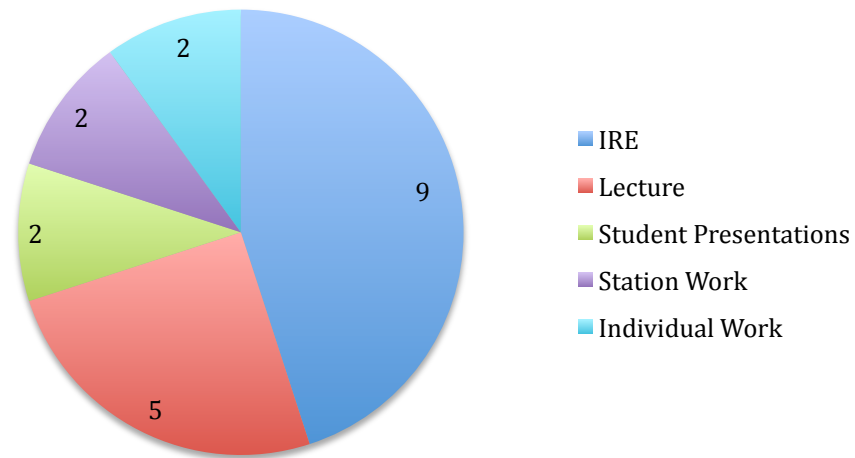


Figure 8. Pie chart of instructional practices.

The previous vignettes illustrate the type of instructional practices employed by the alternatively certified teachers in their first year teaching. However, teachers in the

group employed various types of instructional practices. I conclude this section of analysis with the following assertions.

Assertion 1: The alternatively certified mathematics teachers in this study engaged in a variety of instructional practices, but Lecture and IRE were the dominant modes of instruction.

Assertion 2: These teachers used non-traditional instructional formats but the lessons varied considerably in quality.

Changes in Instructional Practices and the Associated Contextual Factors

In this section, I begin with an overview of the teachers' instructional practices over the three years. I divided the teachers into four groups: those who used lecture at least twice, those who used IRE at least twice, those with missing data, and finally teachers with varied instruction year to year. In order to form these groups, each observation for the 25 teachers was analyzed to identify the major style of teaching practice that each of the teacher employed from year to year. Missing data is identified with a '-' in the tables. The presence of an '*' next to an instructional practice in the Y1 column indicates that this teacher's lesson was described in detail in the previous section of instructional practices.

Three teachers, D2, E2, and F2 used lecture during all three observations. Teachers B3, B6, and B7 used lecture during two observations.

Table 9

Teachers observed using Lecture at least twice

Teacher	Y1	Y2	Y3
B3	-	Lecture	Lecture
B6	-	Lecture	Lecture
B7	Individual Work*	Lecture	Lecture
D2	Lecture*	Lecture	Lecture
E2	Lecture	Lecture	Lecture
F2	Lecture	Lecture	Lecture

* indicates that this lesson was described in detail in the previous section of instructional practices

Teacher D1 used IRE during all three observations. Teachers B2, B8, E1, E5, F3, F4, and H1 used IRE during two of the three observations. Three teachers, B2, B8, and F3 used Individual Work in the third observation. These lessons were absent of instructional practice and resembled a study hall.

Table 10

Teachers using IRE at least twice

Teacher	Y1	Y2	Y3
D1	IRE	IRE	IRE
B2	IRE*	IRE	Individual Work
B8	IRE	IRE	Individual Work
E1	IRE	IRE	-
E5	Student Presentations	IRE	IRE
F3	IRE	IRE	Individual Work
F4	IRE	Lecture	IRE
H1	IRE	IRE	IRE/ Individual Work/ Group Work

* indicates that this lesson was described in detail in the previous section of instructional practices

These two tables account for 14 of the 25 teachers, using either lecture or IRE for at least two of the three observations.

While examining the remaining 11 teachers a new instructional classification emerged from the data, “Whole Class Discussion.” This classification differs from IRE in that the teacher operated as a moderator for a discussion with the students, rather than as the focus of the conversation. Frequently the teacher would defer to the students when asked if a question were “right,” or if students asked, “what do we do when...” Teacher B4 used this strategy in the third year observation and teacher E4 used it in part of her third year lesson.

Table 12 represents the teachers who did not use any strategy more than once or had missing data. Teacher G2 has been included in this set because she had little choice in her instructional practices in the first two years.

Table 11

Teachers using various strategies or have missing data points

Teacher	Y1	Y2	Y3
A1	-	Lecture	-
B4	IRE	-	Whole Class Discussion
C2	IRE	Individual Work	-
E3	-	IRE	-
G1	-	Individual Work	Group Work
G2	Individual Work, Computer Created Curriculum*	Individual Work, Computer Created Curriculum	IRE

* indicates that this lesson was described in detail in the previous section of instructional practices

Table 13 presents teachers who were observed using different instructional practices in each of the visits. These teachers stand out from the others in that no one practice typifies the teaching practices observed from year to year. Teacher E4 began by using lecture, but in the following observations used strategies that mixed a variety of instructional practices. Together, the five teachers B1, B5, C1, E4, and F1 represent the teachers with the most variety in their instructional practices.

Table 12

Teachers with varied instructional practices

Teacher	Y1	Y2	Y3
B1	Student Presentations	Lecture	Whole Class Discussion
B5	Station Work*	Group Work	IRE
C1	Lecture	IRE	Group Work
E4	Lecture	Group Work/Lecture	IRE/Group Work/Whole Class Discussion
F1	Group Work	Individual Work	IRE

* indicates that this lesson was described in detail in the previous section of instructional practices

In the following sections, I highlight four teachers using a case study to investigate the changes in instructional practice over time.

Unchanging

More than half of the teachers utilized only one approach to teaching. As I analyzed the data, I found that not all teachers whose practice did not change were isolated from other factors, such as school context. I analyzed teacher F2 for a deeper investigation into the teachers who exhibited no change in instructional practice from

year to year. I chose this teacher particularly because lecture was a typical instructional format and he underwent some changes that provided opportunities to adjust his teaching style. I have named this teacher “Talat” to facilitate and personalize the following account.

Table 13

A teacher with no changes in instructional practice

Teacher	Observation date		
	Dec 2004	Nov 2005	Sept 2006
F2 Talat	Lecture	Lecture	Lecture

The Case of Talat

Background. As an engineering major, Talat decided just before graduating from college in Iowa that engineering was not a career he wanted to pursue. He was 25 years old and knew he enjoyed working with high school students, and so he began looking for districts willing to hire non-mathematics majors with no teaching credentials. He left Iowa and traveled to Missouri after finding a high school that was interested in his coaching skills as much as his content knowledge. He began his alternative certification program shortly after accepting this position.

Talat considered himself a “people person” and saw finishing his engineering degree as simply a “means to an end” to finish school and then find a teaching job (interview, October 2004). Talat said, “I also liked giving knowledge” as a reason for entering teaching (interview, October 2004).

Talat had been hired in his first school on a provisional basis the previous year. Observations for this study occurred in his second year at the high school. The provision

was that he enroll in an alternative licensure program. He was observed three times over the three-year study.

Instructional Practices over Time

In the following sections, I present the three observations of Talat's lessons as viewed through the four aspects of the instructional practices framework from Figure 1. Following these sections, I discuss an analysis of the three years of Talat's lessons.

Observation 1

Observation 1, December 2004. This school was designated as rural. This tenth through twelfth grade, algebra 2 classroom contained 22 students in total. The students were Hispanic and white. The content was intended to prepare the students for the state assessment.

Pedagogy. Talat distributed a review sheet and stayed at the front of the room while the students worked individually. After about 15 minutes, he asked students to volunteer questions they needed help with. Talat began working the problems on the board to show them how to do them without further student input. Talat made no efforts to use any other instructional strategies, noting later in the interview, "the students want to be spoon fed and resist any other form of instruction" (December 2004, quoting something he said off-tape). There was little interaction other than when the students told the teacher which problems they wanted him to work (observation, December 2004).

Talat's school district used the Saxon Math Curriculum, and this lesson served as a review for the MAP test. The desks were arranged in rows, but due to the poor resources of the school, there were not enough desks for everyone. The teacher had four students sitting at a grouping of desks that allowed two students to sit with their backs to

the teacher. During the lesson, these two students were off-task and did not look at the board or the teacher (observation, December 2004).

Design of the Lesson. The purpose of the lesson was state test preparation (observation, December 2004). Talat provided students with a state test review sheet and told them to work on it for 15 minutes at which time he would go over the problems they encountered (observation, December 2004). After the designated time, the teacher worked through the problems the students were having trouble with. There was no planned interaction other than when the students told the teacher which problems they wanted him to work (observation, December 2004). This lesson required little planning on the part of the teacher, and while the students were working he used the time to call students to the front to show them their grades.

Content. The sole purpose of the content was to prepare the students for the state test (observation, December 2004). Talat portrayed the content as something to know for the state test (observation, December 2004).

As far as mathematical skills and knowledge, he did not let the students use calculators until they knew “how to multiply and divide on their own” at which time they would have earned that “privilege” (observation, December 2004).

Talat maintained the role of authority of the content. For instance, he worked through the problems with the class as a whole, but did not use small groups, cooperative learning, discovery, seatwork, or have kids go to the blackboard to work out problems (observation, December 2004).

Mathematics did not appear to be a dynamic body of knowledge, as Talat’s focus was on particular formulas as tools for solving particular problems (observation,

December 2004). This was likely due to the nature of the task, which was preparation for a state test.

Culture of the Classroom. There were not enough desks for everyone, so there was one pair of desks that was used for four students. Talat made no effort to draw student attention to the board when he worked out problems for the class implying that their attention was not required. The school culture did not help the situation, as other teachers told Talat that the students were incapable of participating in group or cooperative learning (observation, December 2004).

When Talat asked the class to be quiet, they usually did not follow his instructions. Once Talat was exasperated enough to say, “Shut up” they eventually settled down. Furthermore, Talat never left the front of the room and many times stood with his arms crossed (observation, December 2004). Talat left this school after the first year, stating,

I was ready for a change, I was ready for a change in environment and schools. One of my philosophies is that as a new teacher, the first two years you make enough mistakes anyway, you can go somewhere else and start new, try some different things, see some different things, and learn from different people, be around different groups of students, and really expand, you know, what your teaching is versus being in the same school year after year and never seeing anything different, you kind of get stuck in a role. So it was kind of those two parts together, as far as wanting to change myself and my teaching, but also getting married and needing to move anyway for spouse’s reasons. (interview, November 2005)

Observation 2

Observation 2, November 2005. This school, also designated as rural, is in a different district than the first observation. This tenth through twelfth grade, algebra 2 classroom comprised two male and five female students, all of whom were white. The purpose of the lesson was to use the law of sine and the law of cosine to solve missing angles and sides of any triangles.

Pedagogy. In the second year, Talat had moved to a new school, in a different rural district. The observed class was algebra 2, including students from tenth through twelfth grade. The lesson was focused on preparation for the ACT test. Similar to the first year, he used a direct instruction method to teach the lesson. He presented formulas for the lesson, law of sine and cosine, and worked a few examples on the board. During this time, he asked for occasional student input such as when he put a triangle on the board with a missing value for an angle and asked the class how would he know what the other angle was (observation, November 2005). He continued with this instructional practice aligned with IRE. He then had the students work exercises individually, although a few of the students seemed to collaborate with other students on these tasks. The teacher neither encouraged nor discouraged this collaboration. Many students seemed to have trouble working individually as they asked questions that demonstrated that the students expected Talat to provide the answers or closely direct their steps.

The textbook had this lesson sequenced for the spring, but since the ACT would occur before this lesson, he moved this lesson to November so that the students would be introduced to the laws of sine and cosine before the test.

Rather than trying to make sense of the formulas, Talat provided “hints” to remember them. For example, Talat stated, “Remember, a,b,c on the top like the alphabet in lower case letters and A,B,C on the bottom portion of the formula.” The most notable aspects of his teaching are the focus on the teacher and the lack of responsibility the students show in their own learning.

In the interview, he reported that the most effective part of the lesson is where all the students were “working on paper” and “making sure they could plug things in.” He did not see many changes that could be made to the lesson, citing that he had tried it two different ways and it did not seem to make a difference. He still thought that students needed to develop “conceptual understanding instead of just punching numbers into a calculator” (interview, November 2005). He expected further misconceptions in the symbolic algebra during the next day’s lesson, but not in the “plugging and chugging” (interview, November 2005).

Design of the Lesson. In the second year, Talat discussed the plans he had for the lesson. When asked about pre-lesson planning, he pointed out that this test preparation lesson was not in line with the typical curriculum. He stated,

Yeah, this would normally, as far as the textbook sequence, this would be one of the last chapters that we would go through in a school year. But, because of previous experience and knowing what’s on the ACT, and also determining where my students are at, this was a good time to teach this unit. (interview, November 2005)

He went on to discuss the related experiences students had up to this lesson that allowed him to make such changes in sequencing. He said,

Yeah, we've talked about the Pythagorean Theorem, they've had that since their first year of math. They've also seen sine, cosine, and tangent in a previous class. And also some of them are taking science classes where they've seen these functions a little bit before, so they've had some surface previous experience with it, not only in my classroom but in other classrooms, but the previous experience that we've had in this classroom has been just working with right triangles, so far. (interview, November 2005)

Furthermore, he anticipated misconceptions and student difficulties with symbol manipulation, but not with the underlying concepts related to the functions they were learning. He stated,

In this lesson, not much because it was just a lot of taking information and putting it into a formula, as you saw in class. Some of it goes back to the actual manipulation of algebra and equations, that doesn't, it isn't much on the actual concept as much as the nuts and bolts of getting from point A to point B, and that's kind of what the expectation usually is, it's not always the big concepts they have trouble on, it's the here and there where they're missing small ideas because of coming out of an integrated text into this traditional curriculum. (interview, November 2005)

In year two, we saw a second lesson on test preparation that differed from the first. He was not only preparing the students for a test by having them work problems, but making plans on how to teach them this content. He spent this lesson actively involved in working problems with the students, rather than for them.

Content. Talat said that the purpose of the lesson was to “use the law of sine and the law of cosine to solve missing angles and sides of any triangles that they could be given when certain characteristics are met” (interview, November 2005). He portrayed the content as requiring memorization. He provided mnemonic strategies that were not relevant to the concept learned. One such example was his instructions on how to remember the formula for the law of sine and the law of cosine. For the law of sine he told them to remember a, b, c on the top like the alphabet in lower case letters and A,B,C on the bottom portion of the formula (observation, November 2005). While this may or may not be easy to remember, it does not help the students make sense of the relationships involved. In this way, reasoning and thinking were minimized in lieu of an emphasis on formula recognition.

Talat did make efforts to connect the laws of sine and cosine to other areas of mathematics. The background knowledge upon which he built included an understanding of angles and side relationships in triangles and the Pythagorean theorem. He used questions like, “What does this remind you of” or statements like, “This is just another form of [the Pythagorean Theorem]” (observation, November 2005).

Culture of the Classroom. Talat was observed as being warm, personable, and confident. There was good rapport between the students and the teacher. He was very caring and interested in whether or not these students learned anything. Despite this change in demeanor toward the students, he did not provide a collaborative working environment, use discovery methods, or implement group work (observation, November 2005).

His style continued to involve lecturing on the concept of the day, working through examples with the entire class and then to have them work a problem out on their own. These students appeared unsure when applying the procedures Talat had just used. They required constant feedback from him, reiterating their preference of Talat being the main authority for the correctness of answers (observation, November 2005).

Overall, the classroom discourse was limited to the teacher's lesson followed by individual work time. Students asked questions of the teacher, but not of each other.

Observation 3

Observation 3, September 2006. This rural school is the same as the previous observation. Again, the class was algebra 2 with tenth through twelfth grade. The students were Asian and white, with four male and seven female in attendance. The lesson for the day was a review of linear equations, a concept the students had encountered in algebra 1.

Pedagogy. This lesson began with a review of homework. Before class started, several students were in the classroom getting help before school. Talat followed up on the help he provided to the students before school by writing a problem on the board that embodied the concepts of domain and range. He wrote half the answers on the board, leaving either the domain or range unanswered, and asked the students what the other half of the solution was. Several students called out what they thought the answers were. He then asked for any other problems students had trouble with, and after receiving a few more, he provided his solution strategy without student input. This portion of class concluded when a student asked "So the answer to the problem is -14?" and another student asked if it could be "- 9 - 5." He said, "yes" to the first and "no" to the second and then moved on into the introduction of new material for the lesson (observation,

September 2006). This segment illustrates that students were willing to take intellectual risks, but the teacher minimized any discourse about the solution process during this homework review.

During the introduction of new material, Talat provided a lecture. The teacher had the students turn their books to page 63. He said, “The big ideas for the day will be linear equations.” He wrote “linear equations” on the board along with “has no other operations than addition, subtraction, and multiplication of a variable by a constant.” He then began an explanation of this definition; “You may be asking what all this gobbledygook means, let me break it apart for you” (observation, September 2006). He underlined words in the definition and began to explain each one. To show addition and subtraction, he put a few examples on the board, such as $x - 5$, $x + 3$, $5x + 3$, etc. He wrote similar examples for multiplication. Next was a linear function, and with this, he not only provided written examples of linear functions, but also related how graphs tied in. He then wrote an equation on the board and asked all the students to enter it in their calculators, using the graphing feature to confirm that it was indeed a linear equation. One student had trouble, and a neighboring student offered help. This sort of collaboration occurred once, and was not teacher initiated.

Throughout the lesson, students diligently took notes. An exception to this occurred at the end of the lesson, and demonstrated that the students were engaged in the lesson. Talat worked through several algebraic steps to complete the final problem. One student questioned these steps, pointing out the elaborate amount needed for solving. Talat asked other students for input. Several responses were offered, and the teacher pointed out that several of the methods would work, and that one student strategy,

multiplying the original equation by -1 on the first step, was particularly effective. He concluded by giving the assignment, and said he would be “the nice guy today” and only gave the odd problems (observation, September 2006). The teacher circulated and helped students on their homework during the last five minutes of the class.

Design of the Lesson. The class began with a review of the previous day’s homework. The teacher went over a few problems on the board. Following this homework review, he began with the “big idea” for the day and wrote a formal definition of linear equation on the board. He then broke this definition apart and explained each piece in terms the students seemed to appreciate. Throughout this segment, he was talking and writing and the students were quiet and taking notes. He then went over example problems out of the textbook. He asked for various input from the students, but primarily they were one-word responses. Toward the end of the lesson there was a lively discussion about some algebraic manipulations in relation to a definition on the board. This discussion seemed unplanned, however, the teacher involved several students in this dialogue. Following the lecture, he assigned homework. The students had about 10 minutes to work before the bell rang (observation, September 2006).

This lesson followed a traditional lecture format. The teacher reviewed homework, presented a set of lesson notes for the students, and concluded with a series of sample problems that required minimal student input. The discussion at the end of class seemed unplanned, but the teacher seemed receptive to using it for learning.

Content. This day’s lesson was intended to review some concepts the students encountered in algebra 1 (observation, September 2006). The teacher took the lead on this review, and provided students with examples of linear equations. For instance, he

told the students that $y=x+5$, $y=3x-5$, and $y=10-5x$ were linear equations, whereas $g(x)=x^4-5$, and $h(x,y)=2xy$ were not. He also drew three graphs on the board to illustrate what was and what was not a linear equation (observation, September 2006). In this way, students were exposed to two representations of linear equations. However, the teacher provided all examples. After the review of linear equations, the teacher worked several example problems from the book. Only one of these problems had a connection to a real-life context. One example problem the teacher worked with the students was a linear function, $P(d)=62.5d + 2117$, that modeled the pressure experienced by a Russian submarine. According to the problem, at 350 ft below the surface, a submarine experiences 23992 lb/ft² of pressure. The teacher said, "That is a lot of pressure." A student echoed, "That is a lot." Beyond this problem, the teacher made no connections to the real world (observation, September 2006).

Culture of the Classroom. The students took notes without teacher prompting. Students were seen before class asking for help with problems from the previous day's homework. Talat helped them and then used that as a platform to offer some suggestions to the entire class once everyone was there. The students seemed to be a highly motivated group, as evidenced by their diligent note-taking and focus during class (observation, September 2006).

Two students collaborated concerning technology in the classroom. During a segment where the students had to input $f(x)=10-5x$ into their calculators, one female student did not obtain a straight line. A student near to her offered to help, and showed her his calculator. Comparing the two, she was able to fix hers. This was the most

student-to-student collaboration observed during the class period (observation, September 2006).

A small group discussion spontaneously developed when Talat worked out on the board a particularly lengthy algebraic manipulation of a linear equation. One student questioned a negative in the solution. Several students began discussing at once, and eventually a student asked Talat if the students could solve it another way. The teacher responded that each of the ways works, but pointed out the value of multiplying by -1 at the beginning of the problem (observation, September 2006).

Talat assigned work to the class, saying “I’ll be the nice guy today” and made most of the assignment odd problems. The students had about 5 minutes to work, which they did individually, and the teacher circulated and stopped to help people who asked him for help (observation, September 2006).

Within-Case Analysis

In the following paragraphs, I discuss the elements of Talat’s teaching within the four areas of the framework for classroom observation. Furthermore, I account for the scoring Talat received from the observers over the three years within these categories as well. In the following table, I present Talat’s scores on the Horizon Protocol instrument for the three years of observation.

Table 14

Talat's Horizon observation protocol scores

Observation	Design of the Lesson	Pedagogy	Content	Culture of the Classroom	Summary
December 2004	2	2	2	1	2
November 2005	2	2	2	2	2
September 2006	4	4	4	4	4

Pedagogy. Talat's pedagogy, although it scored higher in the third observation, did not change much over the three-year period. The first two years showed only a slight change from lecture in Observation 1 to continued lecture with limited IRE pedagogy in Observation 2. The third observation indicated that Talat still preferred a lecture style, although he allowed the class time for discussion when they were willing to interject. However, themes of *communication* and *source of questions* emerged during the analysis, providing evidence of changes in Talat's pedagogy, despite his lack of change in instructional format.

In the first observation, the *communication* between people in the classroom was minimal. His initial directions to the class were for students to work individually for about 15 minutes, an example of *one-way communication* between teacher and students. While students worked, Talat informed students one at a time about their current grades, but nothing about mathematics. Other communication observed was when students told the teacher which problems they were having trouble with, another instance of *one-way communication* from students to teacher. Talat worked these problems on the board with no further input from students; again, this was one-way communication from teacher to

student. Although there was interaction between the teacher and the students, it was never a conversation that could be classified as two-way. Talat confirmed the nature of communication in the class when he said that the students wish to be “spoon fed.” Where the two students were seated with their backs to the teacher, *two-way communication* was observed between students and students, however, the conversations were off-task and did not apply to the lesson.

For the second observation, *communication* occurred in ways that were both similar and different than in the first year. Talat used direct instruction to deliver a series of notes to the students, an instance of *one-way communication*. When Talat began working example problems for the students, he opened up room for *two-way communication* by using IRE rather than direct instruction. Students were permitted to answer questions while Talat worked through the examples. Communication ceased when students were instructed to work individually. Although *two-way communication* between students and students occurred when a few students worked together, most students asked questions of the teacher. Talat’s value of *communication* seemed to be a minimal focus. The data revealed that he felt the lesson was particularly effective when the students were “working on paper.”

The third observation revealed new aspects of the *communication* theme as well as elements of the previous years. Talat was engaged in *communication* with students before class. Using issues brought up before school, he initiated the period by addressing these problems with the class, and then provided solutions to the other homework problems.

A second theme emerged in the data on Talat's pedagogy. Although Talat provided students with mathematical problems to work on, the *source of questions* he used originated within the textbook. Talat was observed using questions such as "what problems do you want me to work out?" Students served as the *source of questions* in the classroom when mathematical difficulties arose. However, these questions were only asked of Talat, and not other students. These questions did not further the teaching aspects of the lesson for the class as a whole, but rather for the individual asking the question.

In the second observation, Talat served as the primary *source of questions* and asked the students for information during the example problems he worked out. Talat's *source of questions* was again the textbook. However, this was a different school using a different textbook than in the first year.

Data from the third observation reveal a new element within this theme. Students were a *source of questions* before school, and Talat used these questions as an instructional resource to start the lesson. While reviewing these problems and others with the class, Talat was the primary *source of questions*, often providing partial solutions and requiring students to provide the rest. The lesson concluded with a student questioning an algebraic procedure that Talat had just worked. This instance of a *question* led into the most elaborate mathematical class discussion seen in all three of Talat's observations. Even during this grading segment, the classroom discourse seemed to exhibit more *two-way communication* than in past years, with students asking clarification questions about what constituted a correct answer representation. However, more in line with the second observation, Talat provided a *one-way* lecture to provide students with relevant notes.

This *one-way communication* is palpable when he stated, “You may be asking what all this gobbledygook means, let me break it apart for you.” During his lecture, students followed along quietly, except for the one instance of student-student interaction when a single student had issues with her graphing calculator and received help from a fellow student. The end of the lecture ended with a breaking from the *one-way* conversation with a student-initiated question, which engaged a large portion of the class. Looking across the three years of observation, Talat was able to find a comfort zone where communication in his classroom fit his personality.

Design. Talat’s first observation documented a lesson design that required little more than for students to show up to class. This is evident as two students were observed sitting with their back to the teacher for the entire period (observation, December 2004). Students worked independently while Talat was otherwise engaged. After students had worked independently, he worked out problems for the students.

In the second year, Talat again was observed teaching a test review. Talat planned this lesson so that he would be working with the students throughout the period. He planned to deviate from his curriculum sequence to help prepare students for the ACT. Although he felt “this was a good time to teach this unit,” his students definitely struggled with the concepts (interview, November 2005). Again, he spent this lesson working problems with the students, rather than for them, a change from the first year.

The third observation began with Talat reviewing homework with the class. This lesson was structured in a way that showed Talat had either planned this lesson out or had taught it so often that he had a plan in mind. New to his lessons was a “big idea” for the day and a structured note-taking segment. His format included asking students questions.

The group discussion at the end of class seemed unplanned. However, Talat involved several students in this dialogue. Talat concluded the lesson with enough time for students to work independently.

Content. The first year, Talat portrayed content as something for individuals to work on and if they could not get it then they needed help from the teacher. The second observation showed Talat portraying mathematics as a series of formulas that could be remembered with mnemonic devices. Again, students relied entirely on Talat for walking them through their difficulties, placing the mathematical authority primarily with Talat. The third observation began with Talat presenting mathematics, but this observation differed from the others in that Talat asked the students what they thought was a legitimate solution to an algebraic equation. In this way he began to share in the mathematical authority in the classroom, something he had not done before. His portrayal of the content as something to be discussed, as well as his integration of technology to analyze graphs corroborates his higher rating in this category in the third observation.

Culture of the Classroom. Talat's scores in classroom culture show the most change of the four categories of the Horizon Observation Protocol, and the qualitative data confirm this.

The theme of *mathematical authority* changed significantly from the first observation to the third. Data from the first observation reveal that both Talat and the students saw the teacher as the mathematical authority. Students were only observed asking Talat for help, and while he worked problems out there were no interjections from other people. The second observation revealed a class full of students who appeared mathematically unsure when Talat was not accessible. Students required constant

feedback from him, reiterating their preference of Talat as the main authority for the correctness of answers. Data from the third year showed a classroom culture that was intrinsically motivated and willing to take intellectual risks. Students were observed working together in helping one another, as well as arguing for solving algebraic problems in different ways. In this observation, Talat allowed students to share in the *mathematical authority*, even if he had not planned for it.

Classroom *management* was a major cultural issue in the first observation. Talat's tolerance of two students to remain disengaged throughout the period suggests that either he was unable to confront the choices of these two students, that he condoned their behavior, or that he was unaware of their behavior. In the second observation, Talat was seen as being in control of his students to the point of being overbearing. Perhaps because he was teaching a concept beyond the students' level, the students seemed completely reliant on Talat for mathematical purposes. Talat's management style was such that students could only look to him for assistance. The third year revealed changes within this theme. Students were on task throughout the period. They dutifully took notes and participated in parts of the lesson that required their input. They helped one another with technology issues without interrupting the entire class, and they participated in an impromptu discussion.

Within the data, the theme of *environment* also revealed changes in the classroom culture. In the first observation, Talat allowed two students to sit with their back to the class throughout the period. These two students were observed as being off-task throughout the period. Although the school resources were inadequate to seat all students, Talat allowed the *environment* to dictate the culture. The second observation took place at

a new school where the resources for seating were adequate for all students. Students were generally on task, and the seating arrangements seemed intended to encourage individual work. Talat's third observation revealed a similar environment to the second year. The only noticeable change over the three years in terms of *environment* was that after the first year, all students were required to face the front of the classroom.

Finally, the *atmosphere* of the classrooms changed over the three years. The first observation revealed an atmosphere of working independently in order for the teacher to accomplish some administrative duties. The mathematical activity that occurred in this classroom happened in spite of the atmosphere, rather than as a result of it. The second observation had an atmosphere that seemed to have all students engaged, but the students' reliance on the teacher for mathematical direction needed improvement. The third observation revealed a classroom atmosphere with many students engaged from before class started up to the end of the period. The atmosphere was conducive to learning and cooperation as evidence by the note taking, student-student assistance, and the whole class discussion of how to solve a symbolic algebra problem. Atmosphere takes cooperation from both the teacher and the students, and Talat's classrooms showed positive changes over the three years of observation and this was reflected in the changing scores in the culture category from a '1' to a '4.'

Although Talat represents a group of teachers showing little, if any, changes in their instructional practice, the framework for instructional practices offers a chance to look at more aspects of the classroom than simply the pedagogy. In this way, we have confirmation of Talat's lack of change in his preference for a lecture style of instruction,

yet the framework provided the chance to find non-confirming evidence that some things were changing that are related to instructional practices.

Moving from Non-traditional to Traditional

In this section, I report on an individual whose instructional practice began with a non-traditional form whose third year practice was observed as IRE. I refer to this individual as “Kanak,” again to personalize the data and facilitate the reading. Table 21 shows the instructional practices observed over the three years. Kanak was observed teaching in a small private school.

Table 15

Teacher changing from Non-traditional to Traditional

Teacher	Observation		
	Mar 2005	Jan 2006	Sept 2006
F1 “Kanak”	Group Work	Individual Work	IRE

The Case of Kanak

Background. Kanak went into teaching after years of working in the Air Force and as a quality assurance engineer. At 50 years of age, she was looking for a change that was more adapted to her family. She also had a daughter that was identified as learning disabled and had struggled in school. Teaching appealed to her, and after 3 years of substitute teaching, she enrolled in an ATCP because she “wanted a job doing things that felt like it was worth doing” (interview, September 2006).

Instructional Practice

Observation 1

Observation 1, February 2005. Kanak taught seventh grade mathematics in a private school. The observation took place in a class with eight male and six female students. The students were primarily white and included a few Hispanics.

Pedagogy. Kanak used a non-traditional instructional style. She arranged students in groups of two or three. The teacher gave each student a large green sheet of paper on which to work. Although students were working in groups, the teacher instructed them to have an individual sheet to turn in (observation, February 2005).

The teacher initiated the activity by asking the students to take the geometry terms they had encountered this year and “Start thinking how you would organize these in a booklet” (observation, February 2005).

The teacher did not give answers to any group, instead she asked questions to help guide their thinking. For instance, a student said that, “An angle is, like, 90 degrees.” The teacher asked this student, “What makes it an angle in general?” When students asked her about isosceles triangles, she responded, “What features make it isosceles?” In another instance, the teacher helped one group work out the meaning of “equiangular” by breaking the word in pieces by covering half the word at a time. Another group was discussing the difference between parallel and perpendicular (observation, February 2005). Kanak helped focus their definition by asking, “What measurement makes them perpendicular?” (observation, February 2005).

This was how the entire lesson progressed with students working diligently while the teacher circulated around the room offering guidance and probing the students with questions that helped them arrive at conclusions.

Design. Kanak did not consider state or district standards when planning this lesson, although she seemed to have some knowledge of what was expected. She stated, "This year, I haven't really paid too much attention to them. I mean, I'm aware of them, and I try to think about, well, I know that they want us to do more higher level cognitive activities with them and stuff, but this year I've pretty much just stuck with the book, just to get through and make sure I didn't miss anything. So I haven't really, I'm meeting kind of the basic criteria of the standards, without achieving any of the higher goals that we're trying to get to with the kids."

(interview, March 2005)

The lesson was designed for students to work in groups of two or three and construct an enhanced glossary of geometry terms. This glossary was to have the vocabulary word, a definition in students' own words, and an example with a picture.

At the start of class, Kanak gave each group a protractor, a compass, and a large sheet of green paper on which to work. She also planned time for the end of class to address difficult terms and conclude the lesson.

Content. The activity was a review of all the geometry terms the students had encountered to date. The students were to make a drawing that illustrated each term (observation, February 2005).

The teacher portrayed the content as something to be investigated and thought about. Students were to think about how to group the terms so that a booklet could be made from this activity. One student asked, "Can we look in our math books?" to which Kanak replied, "Not yet." Although students were not using textbooks, collaboration

within groups was expected. The teacher gave the groups a protractor and a compass to assist the drawing process (observation, February 2005).

The teacher encouraged sense-making by asking questions to focus ideas. For instance, when Kanak asked the questions, “What makes it an angle in general?” “What measurement makes them perpendicular?” she was focusing the students’ thinking (observation, February 2005).

Toward the end of class, the teacher began questioning the class on terms that have proved difficult for the students. She did not give them answers to these terms, but asked if any groups had a drawing of the following terms: congruent, bisect. She also asked groups questions about the difference between two related terms. For instance, she asked one group, “What is the difference between a segment and a ray?” (observation, February 2005). At least one student made a connection between the geometry terms and real life. For example a student offered this statement to his group, “I have a good example of a plane: a chalkboard.” The other students in the group agreed (observation, February 2005).

Culture. Kanak and her students had negotiated an atmosphere of working on the tasks as given by the teacher. The teacher described the assignment for the day and placed the students into groups. When a student asked for a particular group member, she responded, “Joe’s going to work with you and James.” This was much to the student’s disappointment, as evidenced by his reaction (observation, February 2005). However, after his initial disappointment, he worked well with his assigned group.

The students were willing to work without teacher input. This was evident throughout the period, as the students were on task and motivated to work. Students

seemed comfortable within their groups. For instance, the students were talking with one another. The teacher seemed aware of the conversations and interjected when she deemed it necessary (observation, February 2005).

The culture of the classroom was conducive to learning and working with mathematics. For instance, Kanak did not give answers to any group, instead she asked questions to help guide their thinking. For instance, a student says that, “An angle is, like, 90 degrees.” Rather than confirm the student’s statement she prodded for further thinking by asking, “What makes it an angle in general?” When students asked her about isosceles triangles, she responded, “What features make it isosceles?” In another instance, the teacher helped one group work out the meaning of “equiangular” by helping them break the word in pieces by covering half the word at a time. Another group was discussing the difference between parallel and perpendicular. One student asked what was the difference, a second student questioningly stated, “Isn’t it where one goes up and the other goes sideways?” The teacher helped focus their definition by asking, “What measurement makes them perpendicular?” (observation, February 2005)

The mathematical discourse involved considerable discussion, all related to mathematics. Examples of student-student discourse: At group 3: Student 1 asked the group, “How do you draw a segment?” Student 2 replied, “Remember, you put a dot at the ends.” To this statement Student 1 replied, “Oh yeah.” Another example at group 3: Student 1 said, “I have a good example of a plane: a chalkboard.” The other students agreed. Another example at group 3: Student 2 asked, “What is an octagon?” Student 3, who had previously been quiet replied, “It has eight sides.” [OC: Student 3 is usually

quiet in this group.] At group 1: Student 1 asked the group, “What’s an equilateral triangle?” Student 2 said, “I think that is where they are all 60 degrees.”

Some discourse within the groups tended toward disagreement and doubt. At group 5: Student 1 asked, “What’s complementary?” Student 2 puts a check, without looking at Student 3, who seemed behind these two. Student 3 seemed to be joking and wise cracking, partly to himself, a lot. Student 3 said, “You’re just waiting for me to catch up.” Then he stated, “Congruent means equal.” Student 1 replied, “We’re not trusting your judgement” (observation, February 2005).

Observation 2

Observation 2, January 2006. Again, this was the same private school as the first observation. This seventh grade mathematics class had three male and two female students, this time all students were white. The teacher was using this class period to gauge the knowledge of the students by conducting a review on concepts of arithmetic operations on fractions and decimals.

Pedagogy. This lesson was taught in a format of Individual Work. The teacher did nothing other than distribute a worksheet packet to the students. The worksheets were “subtracting fractions,” “multiplying fractions,” and “dividing fractions.” These worksheets had almost no words on them. Only one problem had words: “Jordan has 21 magazines. That is 1 more than twice the number of magazines Bridgette has. How many magazines does Bridgette have?” All the other exercises were just numbers without words. The students began to work immediately, there was no collaboration between students. The teacher helped students who raised their hands. When students finished, they found something to work on. For instance, one boy read a book. Two other students

finished and then she gave all three of the students the second worksheet. There was no obvious sense-making of note and no formal wrap up (observation, January 2006).

This was all review for the students, and they worked alone for the most part. When two boys finished the first sheet, she gave everyone the second worksheet. This one dealt with the same concepts only with decimals and integers (observation, January 2006).

Design. The lesson seemed designed to occupy the students' time. The lesson was a review and the teacher did not present any information. As the lesson occurred, it was apparent that Kanak planned on having the students complete a worksheet on their own and raise their hands when they got stuck.

Content. The teacher was using this class period to gauge the knowledge of the students and to review the concepts of arithmetic operations on fractions and decimals (observation, January 2006). This content did not seem appropriate for a seventh grade mathematics class, especially considering the lack of context for the problems.

Culture. The students began working immediately upon receiving the worksheets. There was no collaboration between students. The teacher helped students who raised their hands. When students finished, they found something else on which to work. For instance, one boy read a book. Two other students finished and then she gave all three of these students a second worksheet (observation, January 2006).

Kanak had the students work on a worksheet of review problems with fractions. They all worked individually and when students had a question they raised their hand. The teacher then went over to them and helped them, but usually she was so quiet that the observer could not hear her. When she did speak loud enough to hear, it was to address

the class. For instance, she said “If you get to the dividing part and forget, let me know and I’ll help you.” She spoke this to one student, but loud enough for everyone to hear. Another comment Kanak made out loud was, “you take the reciprocal of the divisor and multiply.” These were the only audible comments heard, and they were spoken loudly to the class of five students. It seemed that if she was helping a student with something that she thought everyone could benefit from, she said it out loud. Otherwise, she helped students so quietly that the speech was inaudible (observation, January 2006).

The seats were arranged so that two desks were together side by side. However, the students did not collaborate during this period (observation, January 2006).

Observation 3

Observation 3, September 2006. This was the same private school as in years past. This sixth grade mathematics class had four male and three female students, all white. The lesson was a review of whole number subtraction followed by a lesson on metric units.

Pedagogy. Kanak used a traditional IRE instructional practice. She took the role of director of the conversation, asking many questions that had only one-word responses (observation, September 2006).

Kanak used an overhead projector to begin class with a short subtraction review and practice for about 10 minutes. Problems were to be done mentally because all problems were the special case where the numbers in the minuend are larger than the subtrahend. Students worked individually during this review (observation, September 2006). There was absolutely no connection between these problems and the rest of the lesson. Kanak’s intent seemed to be to have the students practice some basic computations (observation, September 2006).

After the review, Kanak wrote on the board “meters, liters, grams.” She then wrote “ones” underneath this and put a decimal point. She drew vertical lines to the left and right of the decimal point. This created a large chart on the board, with the intention of writing in the place value names under these regions, along with associated metric prefixes. Kanak had the boys call out the units (for example, “tens” “hundreds”) to the left of the ones, and had the girls call out the units on the right (for example “tenths” “hundredths”). She then asked for prefixes. Between the seven students, they were able to get all of them. The first called out by students are “kilo-” and “milli-.” When they say “milli-“ the teacher related “milli-“ to “millipede” because it “looks like it has a thousand legs.” Once all the prefixes were filled in, the teacher praised the students with “you guys are so good.” She continued with questions like, “for kilo- we use ‘k’, hecto- we use?” to which a student (or students) responded with the answer. The teacher commented that “you guys just about have all this memorized.” At that point, Kanak noticed that none of them were writing anything down, and told students they should get out their notebooks and copy this chart from the board (observation, September 2006). This lesson lasted 20 minutes.

During the lesson on metric units, the students were able to provide all of the prefixes, all of the powers of ten, and most of the corresponding standard units. This conversation was mostly a review, as evidenced by the teacher’s statement “You guys have all this memorized” (observation, September 2006). Kanak did try to elicit real-world connections from the students during this lesson. She asked what seemed to be an obvious question to her, “what do we see in liters all the time?” One student verbalized that a liter was close to the standard unit measure of a half-gallon. Kanak corrected him

with a visual example showing a graduated cylinder. There was little connection between the lesson and real life (observation, September 2006).

Kanak acknowledged the students' previous work with this topic and indicated the areas they may have been weakest in. She said,

What we did today, they had all seen it before. I don't think that any 6th grade, they haven't really mastered the ability to move, like to say, 'If I have ten decimeters, how many centimeters is that?' That was not mastered last year. It was attempted last year, so I guess my goal this year would be, 'Okay, we did this whole thing with place value, this is the same thing. How do you move these around?' (interview, September 2006)

However, she spent all of the lesson time having students recall the names of the prefixes and then having them copy the chart off the board. She did not spend class time working with, in her own words, "moving the decimal around" (interview, September 2006).

Design. In planning this lesson, Kanak considered some of the previous experiences students had. She stated,

I started the year off with the whole numbers system and working with them in place value. We did Popsicle sticks and all the different place values and all the kind of stuff, trying to make it concrete so that as they learned the names, it was just practice learning the names. The kids who don't seem to quite get the base ten system, I really tried to talk about what is base ten. And we did a little bit like if it was base three or base four, just to show differences and kind of get them into the idea of "base ten is not magic, it just happens to be base ten" and that's why everything is in tens, because it's base ten. And they finally got that idea, and so

then I'm trying to use that common theme to tie everything else we do into it, so that they understand that when we get to fractions, the reasons you're stumbling over fractions is because it's not base ten anymore. Whole numbers are base ten, but the partial numbers are base four, or base five, or whatever fraction you're doing. So I'm trying to put everything in that kind of context" (interview, September 2006).

Despite this background, Kanak started her lesson off with a review of basic subtraction problems. Although the metric units allow for working with fractions, Kanak focused her lesson almost entirely on the memory aspect of what prefixes go with the units.

Her pre-lesson planning only vaguely relied on standards or curriculum documents. Kanak stated,

I use the GLE's to kind of keep me on track. And we have a diocesan curriculum that I look at to make sure, am I covering the things in the diocese that they expect the kids to have accomplished each year. But beyond that, nobody else checks to see if I'm doing everything. (interview, September 2006)

This freedom to teach whatever she wanted seemed to leave her without a focus on what to teach and perhaps what to expect. When asked if she expected the students to have any difficulties with the day's lesson, Kanak had this to say, "Not at this level. But, I was very pleased that they remember that many of the names. I didn't expect them to." Noting that the students were able to provide her with all the prefixes, she said with a laugh, "Yeah, they did! And I think in my 7th grade, they did better than part of my [other classes]" (interview, September 2006).

Reflecting on the problems students may have with the homework she sent them home with, she said,

Well, this homework I gave them, the paper with numbers 1-15, because we didn't get to really practice moving the decimal around. Or, I think, several of them, well, two of them won't be able to do it all probably, or won't have any correct answers. Two of them will figure it out, and the other two, I think, will get some of it but they'll probably come back tomorrow with a lot of questions. But that's okay, cause that's why I said just try these 15 here." (interview, September 2006)

Here the feeling conveyed was that Kanak expected particular students to do well and other students to do poorly. However, she made no attempts during the lesson to alleviate student misconceptions and instead spent the lesson reviewing something the students already knew.

Content. The lesson today was a review of three-digit subtraction and of metric units (observation, September 2006). Three-digit subtraction computed mentally seemed inappropriate, however, this was not the main focus of the lesson. The lesson on metric units was not appropriate in the manner presented.

Kanak expected the students to perform the subtraction mentally, although at least one student wanted to write down the problems. The exercises were disconnected from a context. For example, one exercise was $427-315$. No mention of where this situation might occur was included. The worksheet that this overhead transparency was copied from looked rather old. All six exercises were similar three digit subtraction problems

that did not require borrowing. After the students finished this brief review, there was no talk about the solutions, or the use of this basic skill (observation, September 2006).

The lesson on metric units focused exclusively on the names and prefixes of various metric units. No examples were seen until the teacher gave the students their homework problems.

When asked about what was coming next, Kanak gave further insight into how she portrays the subject of mathematics. She said,

First we'll just do it with whole numbers, just to make sure everybody is fairly solid there, and then we'll move right on into decimals since we've been doing decimals the whole time. And what I keep telling them, it works the same way. Whether its $7/10$ or $7/100$, if you multiply it by 7 it's still 49-something. So that helps them, when they finally figure out that the decimal is just there. With the multiplication I say, 'Work the problem first, then worry about the decimal.' And with division, 'Move the decimal first, and then just work the problem.' I mean, either way, it's like once you're done, you're just doing the numbers and then you're doing the decimal. So you don't have to think of them at the same time.
(interview, September 2006)

Culture. Kanak and the students had negotiated a classroom culture that was open to discussion. The teacher took the role of director of the conversation and students were expected to provide input as they were questioned (observation, September 2006).

Most student work was individual; however, two boys and two girls seemed to work together toward the end of the period. They whispered or talked quietly so as not to disturb the other students (observation, September 2006).

Kanak maintained control of the mathematical discourse and demonstration during the lesson. The students were never involved with actual items used to determine measurements. For instance, Kanak showed the class a graduated cylinder to show a student why a quart is closer to a liter, and later she showed them a gram as measured by a small brass weight (observation, September 2006). The students never handled these items nor did they get out of their seats.

Within-Case Analysis

Kanak’s scores on the Horizon Protocol instrument for the three years of observation.

Table 16

Kanak's Horizon observation protocol scores

Observation	Design of the Lesson	Pedagogy	Content	Culture of the Classroom	Summary
May 2005	4	4	5	5	4
January 2006	2	2	2	2	1
September 2006	3	2	1	3	1

Pedagogy. Kanak’s pedagogy differed significantly from year to year. These differences are reflected in her scoring, which initially was a ‘4’ and subsequently dropped to a ‘2’ for each of the following years. The first observation was of a lesson that required students to work in groups and for the groups to function with minimal interaction with the teacher. The second observation revealed a classroom of individual group work, in which instruction was mostly absent. In light of the data, the score for this year should have been a ‘1.’ The third year, Kanak employed an IRE style of teaching.

Kanak also directed students to take notes and provide specified feedback to questions she posed. However, the content chosen was redundant as evidenced when she said to the students that they had memorized all the information she was teaching. To inspect the differences, consider the themes of *communication* and *source of questions*.

The pedagogy observed in her first year involved having students working in groups on a project compiling geometric vocabulary terms. Kanak served as a resource in the classroom, but did not supplant student thinking. Students *communicated* primarily with one another. Within their groups, students were constantly talking and discussing how to represent various geometric concepts. The second observation showed a lesson with almost no *communication* at all. Occasionally a student asked Kanak a question by raising a hand. Other than that, there was no verbal communication. The third lesson had the teacher directing conversation through an IRE format. In this way, students provided short phrases and single words to the teacher. Over the three years, Kanak's pedagogy varied between student-student communication, minimal conversation, to teacher-student communication.

For *source of questions*, Kanak's first lesson revealed students as the primary source of questions to one another. For example, within one group a student asked the others, "How do you draw a segment?" Kanak also played a role in questioning, as she questioned groups that needed a push to arrive at valid definitions in their vocabulary projects for instance, when she asked on group, "What features make it isosceles?" Students in the second observation were the only *source of questions*, which they only asked the teacher. Finally, in the third observation, Kanak served as the primary *source of*

questions as she led the students through a note-taking segment on recalling the prefixes for various powers of ten in the metric and standard measuring systems.

Design. Kanak's design score started quite high, but over time her design declined. The first year's observation seemed well planned out to include all students in an activity meant to personalize what they were learning. Kanak grouped the students deliberately, and provided them with clear instructions. She was active during the lesson in monitoring students work and she provided a clear summary toward the end of the period. Off tape, Kanak revealed that this activity was being used to help fulfill some of the requirements for her certification program. This may explain why the second and third observations were drastically different from the first. The lesson of the second year seemed to be a planned period of busy work for the students. She had all students working individually and not in groups like the previous year. The third observation showed a higher degree of planning than in the second year. This difference is also seen in the Observation scores in which the design score was a '3' as opposed to a '2.' However, Kanak built her lesson to focus on review of the names of units rather than in the concepts involved. Further evidence for this planning was revealed when she discussed afterward about which students would succeed on the homework assignment and which would struggle. Despite this recognition, Kanak's planning did not attempt to address these issues. The third observation data revealed that Kanak, in terms of teaching mathematics, had no one with which to collaborate.

Content. An interesting comparison can be made between these three observations as all of them involved a review of content. The first year observation content was grade appropriate and was presented in a way that made the students think about what they

knew and put this into written form. The teacher asked the groups questions focused on the concepts within the content, for example, “What makes it an angle in general?” (observation, February 2005). These questions were individualized per discussion as Kanak walked around. Kanak provided a final wrap up by discussing a few terms that many groups had trouble with. She invites the groups to share their ideas with these terms. She also identifies closely related terms and has students share with the class what differentiates them.

The second observation was also a review, this time of multiplication and division with fractions and decimals. Rather than have students work together on a project, she had them work independently on a worksheet. The review seemed focused on what procedures students remembered rather than on a review of recent grade-appropriate content. The content was not discussed as a whole class at either the beginning or the end of the period.

The final observation began with a short review of basic facts followed by a teacher-led review of metric and standard units of measurement. The basic fact review was inappropriate content for a seventh grade class. However, it only took a few minutes and the teacher moved to the main lesson on units of measure. This review was similar to the first year, in that the lesson focused primarily on vocabulary. However, Kanak taught the lesson almost as if it were new to the students. She split some tasks to the boys and other tasks to the girls. This differed from year one when all groups were responsible for all vocabulary terms. This time students were at most responsible for half the prefixes (i.e. cent, mil, tril, etc). Furthermore, students waited for Kanak to present examples rather than think of their own as the students had in the first observation.

Kanak's scores in the content category started high and ended at the lowest category. Kanak's first observation showed grade-appropriate material being reviewed in a way that required students to think and relate new vocabulary words and write down their work. The second and third observations were lessons that were on content that was not grade-appropriate and that were rote procedures.

Culture. Over the three years' ratings, Kanak's culture ratings of '5,' '2,' and '3' are reflected in the observations. By looking at the observational data in terms of the mathematical *authority* as well as the *atmosphere*, a rationale for these ratings is easy to see.

Within Kanak's classrooms, the theme of mathematical *authority* changed greatly across the three years of observation. In the first year, Kanak placed the mathematical authority in the hands of the students. She rarely answered a student's question with an answer, but rather required students to think about concepts for themselves. When they still had trouble, she prompted them with leading questions. Students may have viewed Kanak as the authority, but her efforts placed the students in a position where they could gain the knowledge without her telling them the answers. Furthermore, Kanak's summary at the end of the lesson provided students with another opportunity to be the mathematical authorities inside the classroom. In the second observation, the structure of the lesson was such that there was no mathematical authority. Students were either able to do the worksheet or they were not. Students having trouble were required to ask the teacher for help, in which case Kanak was the authority. However, the limited conversations in this classroom were so quiet that the content of these questions could not be determined. The third observation revealed a classroom in which the mathematical

authority was shared between the teacher and the students. Kanak's questions required students to provide answers, to which she then confirmed or corrected. Kanak maintained a greater portion of the authority in providing examples of various units of measure. Even though she had various measuring devices in the room, she was the only one who handled them.

The classroom *atmosphere*, that is, how conducive the lesson was to learning mathematics, varied over the three observations as well. The first observation had an atmosphere of productive collaboration. One attribute of this atmosphere was the noise level. The classroom was never loud, but students were talking and discussing mathematical concepts. This contrasts greatly from the second observation, which had an atmosphere of silence. The voices in this class were so quiet that all of the conversations between the students and the teacher were inaudible. It is hard to say if students were learning mathematics, but they were practicing skills. Furthermore, the teacher was not talking with the students for most of the period. The third year had an atmosphere of sharing information as a class, in line with the teacher's questioning. The lesson was productive to learning and working with mathematics. Unfortunately, the lesson was a review that served no purpose other than for the students to take notes on what they already knew.

The case of Kanak provides evidence that changes in instructional practice, as described by teaching style, do not guarantee that the instructional practices are effective. Furthermore, Kanak's location at a private school was not a factor in maintaining effective teaching practices and provided little supervision or support for her professional development.

Moving from Traditional to Non-traditional

This section focuses on those teachers who began with a traditional teaching style. I include a description of the teacher who began with a lecture style because lecture is somewhat related to IRE in that the lesson is heavily reliant on the teacher for input. Although teacher H1 was observed with a non-traditional style in the third year, she used the same practice in the first two years. Teacher C1, who I have named “Ava,” transitions through three instructional practices over the years, allowing for a richer study of instructional change over time.

Table 17

Teachers changing from Traditional to Non-traditional

Teacher	Observation		
	May 2005	Nov 2005	Oct 2006
C1 “Ava”	Lecture	IRE	Group Work

The Case of Ava

Background. Ava fell into the teaching profession by chance. At age 32, she had already spent several years working in the mortgage banking industry where she was able to make use of her degree in mathematics. Eventually she had two children, and while caring for them, she looked for a way to get out of the house a few days a week. For four years, she was a part time substitute teacher and taught at all grade levels, from pre-K to 12th grade. Ava had always been organized, and through her life experiences with her own children, with school children, and teaching Sunday school, she had learned patience. This life path drew her into the teaching field.

Instructional Practices over Time

As a teacher, Ava was highly energetic. She almost never sat at her desk, not even during a test. Between classes, she preferred to be in the halls, mingling with the students. In class, she was sensitive to individual student needs.

Observation 1

Observation 1, May 2005. This school was designated as rural. This eleventh grade, algebra 2 classroom contained three males and four females. The students were white with one exchange student from Indonesia. The mathematical content of the lesson was sequences. The class worked with recursive formulas as well as explicit formulas, and arithmetic and geometric sequences.

Pedagogy. The first year's lesson focused on a worksheet with vocabulary words related to sequences, Ava working example problems on the board for the students, and independent student work. Her instructional style consisted of lecturing to students with little teacher-student interaction. She had the seats arranged in rows with all seats facing the front of the room. The students worked independently on the vocabulary worksheet at the beginning of class. Ava focused on the repetitive nature of arithmetic and geometric sequences, in that each problem was solved in the same way as previous problems. Her questions to the class required very little feedback from the students. When students demonstrated difficulty, Ava immediately completed the assigned task for the students, following up with rhetorical questions such as, "does that make sense?" (observation, May 2005). She emphasized that the procedure for solving problems was the same as the day before, or similar to the previous problem. The content level, though grade-level appropriate, was focused on applying procedure without connections to meaning.

Design of the lesson. On a professional level, Ava focused first on the state standards. Upon accepting her first job as a mathematics teacher, she found that many classes had been taught the same mathematics content despite the different course titles. She found the situation somewhat overwhelming, stating, “sometimes I feel like I’m digging out as it is, but I am trying, I’m getting there” (interview, May 2005). Ava, being the only mathematics teacher in the school, inherited the previous mathematics teacher’s curriculum that consisted of teaching all the classes the same lesson, regardless of grade level or subject.

Content. The mathematical content involved numeric sequences. By using the vocabulary worksheet, Ava encouraged students to use proper terminology. The class worked with recursive formulas as well as explicit formulas, and arithmetic and geometric sequences (observation, May 2005). The mathematical activity in this class was dependent on the teacher’s presence as she did all the work on the board with limited input from students.

Ava made little connection to other aspects of the mathematics or to real world situations. Most problems had little sense making, and were not very oriented to producing content specific abstractions. Two example problems from the class (which are very illustrative of the rest of the questions): 1) Find the first 4 terms of the sequence, $t_1=132$ and $t_n=t_{n-1}-6$; and Write a recursive form for the sequence 76, 19, 19/4, 19/16, . . . (observation, May 2005). There was little connection to other mathematical aspects or real life context.

Culture of the classroom. During the first year, the students viewed Ava as the sole source of mathematical authority. Students were free to ask for help, although one

student tended to dominate the teacher with his questions and comments (observation, May 2005). The teacher seemed unaware or unable to deal with the dominating presence of this particular student.

Observation 2

Observation 2, November 2005. This is the same rural school as the previous year. This eleventh grade, algebra 2 class comprised three males and six females, all white. The lesson was a review of mathematical concepts focused on the nomenclature and skill-based symbolic manipulation associated with square roots, radicals, and fractional exponents.

Pedagogy. During the second observation, students were seated in three groups of three, with all groups along the front row of the room. To start the class, Ava asked students, “do you know what a radical is?” After some discussion and most of the class nodding in agreement, she placed an overhead on the projector for the class’s notes for the day. The notes provided the general nomenclature associated with square roots, n th roots, and other terminology associated with radicals. During the lesson, the students were engaged in answering questions posed by the teacher such as, “what do you do with exponents?” and “what do you divide?” (observation, November 2005). The class period concluded with the students working in groups on the homework assignment (observation, November 2005). During the lesson, Ava served as the primary source of questions, although she encouraged further interaction with her students, the primary instruction was lecture delivered through note-taking.

Design of the lesson. Her challenge during the second year was working with underprepared students from the middle school. She commented, “I find myself sometimes having to teach instead of review. We’re having to build the foundation when

I should be reviewing and building on what is already there” (interview, November 2005). Ava anticipated that the students would struggle with the lesson because “the ones I had last year didn’t know [roots and exponents], so I’m expecting this [difficulty]” (interview, November 2005).

Content. The mathematics in this lesson focused on square roots, nth roots, and other terminology associated with radicals, an appropriate topic in Algebra 2. The lesson appeared to be a chapter review (observation, November 2005).

There were content specific abstractions, building toward symbolic manipulations until they are quite complex, and providing the students with problems that would challenge their manipulation skills, for instance simplifying $-\sqrt{(q^3+5)^4}$. However, there were no connections made between the real-world, other disciplines, or even within other conceptual areas of mathematics. Instead, the focus of the lesson clearly was on arriving at the correct answer to a particular exercise (observation, November 2005).

Culture of the classroom. In year two, Ava reported that motivating students was her biggest challenge, and acknowledged that her weakness was usually managing particular students. She stated,

You always have the class that has one that doesn’t want to do it. Even in the small classes, which most of them are, nine is probably my average, all it takes is one and it’s off track. It gets off task. And it’s like, I wish I could find something that we could motivate all at the same time. (interview, November 2005)

She realized her management problems involved only a single student in any given class, but still she struggled with dealing with these individuals. However, she was making changes in the physical arrangement in her class to try to deal with this issue. The

classroom was organized with desks in five groups. Students in class were seated in three groups of three seats, and all groups were at the front “row” of the room. The teacher reported that she got the idea to set up the class in this manner from her instructor at her ATPCP who observed her class and gave her feedback, including the suggestion to group the desks. The teacher noted that the move had helped with group work (observation, November 2005). During the lesson, the students were actively engaged in answering questions posed by the teacher as noted above. There were also evident collaborative relationships between the students, as well as between the students and the teacher. This was clearly apparent when the students worked on the homework assignment, as they interacted positively with one another (observation, November 2005). Throughout the class discussion, the students were encouraging and offered positive comments, such as “good job” when another student would answer a question correctly (observation, November 2005).

Observation 3

Observation 3, October 2006. This is the same rural school as in the previous years. This algebra 2 class of tenth through twelfth graders was comprised of four males and eight females; all students are white. The lesson was on finding the dimension of a matrix, subtracting two matrices, evaluating the linear combination of two matrices, finding the dimension of a product, and evaluating a product.

Pedagogy. The first part of class consisted of seatwork with the students answering five questions about matrices including finding the dimension of a matrix, subtracting two matrices (B-C), evaluating the linear combination of two matrices ($3C+2B$), finding the dimension of a product ($5 \times 2 \times 2 \times 4$), and evaluating a product ($2 \times 3 \times 3 \times 2$). After seatwork, Ava provided answers to the homework as students graded

their own work (observation, October 2006). During this first 15 minutes of class, the teacher served as the source for answers to the seatwork.

Following seatwork, Ava engaged students in solving various types of problems. Ava distributed a three-part worksheet. Part 1 was scalar multiplication, part 2 was addition and subtraction, and part 3 was matrix multiplication. Each group was assigned a different section (observation, October 2006).

While the students worked in their groups, the teacher circulated through the class. She encouraged all students to work collaboratively. For example, she asked one student who did not seem to be working much with the group, “will you be presenting, since you don’t seem to be helping with working out the steps” (observation, October 2006).

The students worked on the various parts of the worksheet for about 14 minutes, and all finished around the same time. When ready, the three groups shared their process and provided examples (observation, October 2006).

Ava consistently referred to the previous lesson when discussing how to perform operations with matrices. For example, when doing the calculator work, she made several references to how much easier using the calculator was than doing long hand. She also tried to reiterate that knowing the dimensions of each matrix was crucial when performing multiplication (observation, October 2006).

Design of the lesson. Ava worked hard to restructure the curriculum she inherited, which had very little variability across the class designations (algebra, geometry, algebra 2, pre-calculus). She reported that the “first couple of years were kind of rough” but in the third year of observation students were accustomed to her teaching style and she had

developed the mathematical foundation needed to move forward (interview, October 2006). In contrast with her first year of instruction, she said that “its not nearly as time consuming” to teach the students, because she was not having to spend so much time covering old material (interview, October 2006).

Content. The content was appropriate for Algebra II. Operations with matrices are standard content such a class. Connections to the real world were not made (observation, October 2006).

Since the focus of the lesson was to learn how to use graphing calculators to compute matrix operations, the content was algorithmic, that is, the content focused around performing certain steps that will let one arrive at a specific answer. The teacher justified this by telling the students that this will be important to know how to do in order work quickly through the ACT test (observation, October 2006).

Students first spent time answering 5 questions: find the dimension of a matrix, subtract two matrices (B-C), evaluate the linear combination of two matrices ($3C+2B$), find the dimension of a product of two matrices with given dimensions ($5 \times 2 \times 2 \times 4$), and evaluate a product ($2 \times 3 \times 3 \times 2$).

Culture of the classroom. In the third year, Ava seemed to have developed a better sense of how to organize the classroom so that it was conducive to learning and student interaction. For instance, the students received critique from the teacher without becoming defensive, and they were receptive to the teachers’ requests to answer questions and participate. The students did not seem shy about offering an answer or a thought to the whole class for discussion. When students did share their ideas, responses were positively received and encouraged (observation, October 2006). Ava’s room was

set up with two rows of student desks on each side of the room, facing the other side with a wide space in between for the teacher to walk through. When asked about this change, the teacher noted that she just changed it recently, and she liked to keep it fresh every month, or every couple of weeks (observation, October 2006). This third observation was full of student discourse about the day's topic. Before the lesson, she stated her plans for initiating this student discourse,

I wanted them to come up with the steps. 'Cause I gave them the steps when we did systems of equations, with three equations, three on those, four equations, four on those. They know the background so that way, seeing how can they do just a little bit of variation and come up with their own steps. And come up with it. I was just going to do it individually. I thought: 'Oh I'll just do it in groups because they might miss one step and somebody else [would catch it].' (interview, October 2006).

Not only did the teacher plan for this group discourse, but the students met her challenge. Class time was used for the students to work with the graphing calculators in groups of three and to come up with appropriate steps to work through a problem. The students wrote down the steps on an overhead transparency, and then shared with the rest of the class, as well as provide an example for the other students to work. The three groups shared their steps and an example problem. Each presentation followed the pattern: work through the steps with the class, focusing on the keystrokes used, and then working through the first problem on the handout. During this activity, all the students participated by working on their own calculators and everyone appeared comfortable with the

problems as evidenced by their signs of agreement. For instance, several students nodded their heads or vocalized “yes” (observation, October 2006).

The students in this class communicated with each other about various topics, particularly about the mathematics content for the day. All students were engaged in the classroom discussion. The students seemed to have developed very collaborative relationships with one another. For example, when one student struggled with explaining a concept, another student (or other students) would verbally try to help them think through the problem (observation, October 2006).

Within-Case Analysis

Ava’s scores on the Horizon Protocol instrument for the three years of observation are displayed in the following table.

Table 18

Ava's Horizon observation protocol scores

Observation	Design of the Lesson	Pedagogy	Content	Culture of the Classroom	Summary
May 2005	2	2	2	2	2
November 2005	3	2	2	4	3, low
October 2006	4	4	4	4	4

Pedagogy. In the first year, a theme of *one-way communication* emerged. Ava used lecture style pedagogy to students seated in rows that all faced the front of the room. The period began with students working independently on a vocabulary worksheet, another example of one-way communication, this time between the students and their assignment. Mathematical problems were approached in only one way, as seen when Ava

focused on the repetitive nature mathematical sequences and solved consecutive problems in the same way. Attempts to diverge from this one-way communication cycle were prevented by Ava's actions. For instance, when students initiated a two-way communication with the teacher by asking for help with a problem, Ava worked the problem out for them and concluded with a rhetorical question.

Analysis of the second observation revealed that the first observation's theme of one-way communication was changing. Only one instance of one-way communication existed, when Ava used lecture to provide students with notes. Other than this, all other aspects of the lesson were *two-way communication*. For example, the class began with Ava leading a discussion with the students, who Ava had seated in groups. Ava no longer used rhetorical questions, but rather used questions to lead mathematical discussions. Ava's instructional practice included using questioning that required student input and discussion, both during the opening of the lesson, and later during the lesson. Ava served as the primary *source of questions* for the classroom discussion.

In the third observation, Ava incorporated aspects of both one-way and two-way communication. Elements of one-way communication occurred during a short segment of independent work at the beginning of class. However, there was another change in instructional practice when Ava provided her students with a group task that required them to present their work with their peers. In this way, Ava moved from being the primary *source of questions* for classroom discussion. This change was accompanied with Ava monitoring students during this time, holding groups and individuals accountable for completing work and cooperating in the assignment.

Design. Ava's lessons in the early years hinted of playing a "catch up" game with students that she perceived to be behind. She talked about having to build a foundation of knowledge that the students should have already had. Considering her pedagogy in the first observation, Ava designed her lesson to focus solely on her and require minimal input from the students. During the second year, Ava reported anticipating student difficulties based on her previous years' experience. Her lesson design changed from a teacher directed lesson to a classroom discussion lesson. By the third year, Ava had taught these students long enough that the students in the observed class were on a solid mathematical foundation on which she built. The third observation showed students with much more responsibility for learning than in previous years. Her lesson was designed to require students to work together and share with one another, mostly independent of her involvement.

Content. All of Ava's observations occurred in the class where she was teaching algebra 2. This allowed an analysis of how Ava treated mathematical content that she taught to the same grade level over three years. Two themes emerged as I looked across the three observations in terms of content.

Throughout the three observations, a theme of *correctness* emerged. In the first observation, Ava encouraged students to use proper terminology. Furthermore, Ava did all the work when students asked for help, possibly to avoid wrong solutions, or less than desirable methods for arriving at correct solutions. In the second observation, the focus of the content was in arriving at correct solutions. Ava's use of problems involving complex symbolic manipulations seemed focused solely on arriving at the solution, rather than focusing on the use of particular mathematical properties or multiple methods for solving.

In the third observation, the focus of the lesson was use of a graphing calculator to computer matrix operations. Ava's focus again was on finding one way to use the calculator to arrive at an answer. Throughout the three observations, the theme of *correctness* seemed unchanged, and Ava was consistent in her treatment of mathematical content in terms of requiring correct procedures to be followed.

A second theme that emerged I called *disconnected*. In the first observation, Ava did not connect the content to other aspects of mathematics or realistic situations. The lesson on arithmetic and geometric sequences appeared to be a stand-alone topic in mathematics, with all problems worked in a procedural fashion. In the second observation, Ava continued to teach mathematics as with a focus on correct solutions, and problems were presented in an entirely abstract sense with no connection to other areas of mathematics, such as geometry, or real life contexts. Again, in the third observation, Ava did not connect mathematics to realistic contexts. However, she did make a connection between mathematics and technology. This is a change from the previous years. This connection to technology was spurred primarily by test preparation, in particular, in preparing her students for the ACT. She repeatedly pointed out the usefulness of the graphing calculator throughout both the class period and during the interview.

Culture of the classroom. Four themes emerged when analyzing the three years of Ava's instructional practices. These are *authority*, *management*, *environment*, and *atmosphere*. I describe these four themes and provide support from the three observations.

Throughout the three years of observation, *authority* emerged as a theme. In the first observation, Ava served as the primary mathematical authority. The students sat in rows and after the lecture asked Ava questions, which she always answered. The second observation showed Ava as beginning to share the mathematical authority with the students. Her opening activity involved all the students in a conversation, allowing for voices other than hers to have authority in the classroom. In the third observation, Ava has relinquished control of the mathematical authority in the classroom, instead requiring students to work together to create algorithms for calculator use that are to be shared with the rest of the class. In summary, the theme of *authority* changed from teacher-centered to student-centered over the three years of observation.

Another theme within the classroom culture was *management*. In the first observation, Ava presents mathematical information in a lecture format that provided some degree of behavior management. After the lecture, Ava permitted students to ask questions. Despite the format, one student's questions dominated this time. Ava was unable to successfully manage this one student's overbearing personality. Ava admitted to management issues in the November 2005 interview stating, "all it takes is one and it's off track." In the second observation, the students seemed well managed, and Ava had them seated in groups and working together. The third observation revealed a classroom atmosphere that was well managed and that held students accountable for their efforts. Unlike issues in the first year, Ava was able to manage those individuals in the classroom that were potentially disruptive. An example of this occurred when she asked one individual student "will you be presenting, since you don't seem to be helping with

working out the steps” (observation, October 2006). In the theme of *management*, Ava was able to rectify issues that she had in her early career.

A third theme that emerged was that of the physical *environment*. The arrangement of the classroom underwent a change from the first observation to the subsequent observations. During her first observation, the desks were arranged in rows all facing the front of the class. Sometime after the first observation, a university professor who observed her teaching suggested that she rearrange the desks into groups when she told him, “I’m making them do group activities and they don’t like it” (interview, November 2005). Observations two and three both documented that the desks were always in groups, and students seemed to no longer dislike group activities. By the third observation, Ava reported rearranging the classroom to “keep things fresh,” offering a stark contrast to the first year row arrangement. The physical environment Ava structured changed from the first year to the others, and this change was initiated by a suggestion from university faculty.

A final theme from classroom culture was that of *atmosphere*. The first year, the atmosphere of the class limited the discourse, both student-teacher and student-student discourse. The student-teacher discourse was primarily between one student and the teacher during the first year. However, the second year’s lesson started with an energetic whole-class discussion led by the teacher. Students were also required to work together, further strengthening the student-student discourse. The third observation revealed a continued use of student-student discourse. The changes in discourse over the three years seem partly due to a restructure of the classroom’s physical environment, along with a change in Ava’s requirement for the students to work together.

Adjusting an Ever-changing Instructional Style

One teacher was making changes to her instructional practices, and had planned on these changes from the start. The following table highlights the instructional practices employed by a teacher I call “Hannah.”

Table 19

Honing skills in instructional practice

Teacher	Observation		
	May 2005	Feb 2006	Nov 2006
E4 “Hannah”	Lecture	Group Work/Lecture	IRE/Group Work/Whole Class Discussion

Analysis of Hannah’s observational data made her stand apart from the other 25 teachers. She indicated “it was mostly me working the problems, which is not always the best. A lot of times we get out the dry erase boards, and I have them work the problems and then I can walk around and see, which I didn’t get to do” (interview, May 2005). Unlike some of the teachers above (B1, Kanak) who changed instructional strategies from year to year, she used different instructional strategies within the lessons for the second and third observations. Teacher H1 employed a similar lesson utilizing a range of instructional strategies, but only in her third year. Hannah’s consistent utilization of a variety of practices throughout each class period merited a closer look. In her first year interview, she indicated that this change was imminent. She said,

It’s also a function of teaching six classes a day. I’m really hoping that I can do less direct instruction and it just takes time for me to develop those plans. I really

haven't had the time to do that this year. But just sort of getting through the day.

Sometimes I'm just like, 'okay, here we go' and it's not as creative as I'd like it to be. (Hannah, interview, May 2005)

From this excerpt, Hannah seems to be teaching by telling as simply a way to get through the first year of teaching. The responsibilities of being the only mathematics teacher in the building were overwhelming during her first year.

The Case of Hannah

Background. Hannah was 40 years old and spent five years working as an economist and 11 years as a homemaker. Before entering teaching, she spent several years substitute teaching after her kids were school-aged. Her degree in economics allowed her to enroll in an ATCP that would grant a Master of Arts in Teaching degree upon completion. When asked why she did not go back into a career in economics, she stated,

I was looking for a career where I could spend as much time with my family as much as possible. And I had always liked, I had thought about math education when I was an undergraduate, but I had gotten too far along in my degree program in economics, so when I decided to go back to school, I thought that would fit really well with my family priorities. (interview, November 2006)

When asked about this undergraduate idea of pursuing mathematics education she continued,

Well, because I always liked mathematics and enjoyed that as an academic pursuit. And I had just grown up with teachers. My parents had both grown up

with college professors, and I saw their lifestyles and how they enjoyed it, so that made me think that I might like it also. (interview, November 2006)

In her third year teaching, she said, “I have plans to stick it out until I retire. We’ll see what happens” (interview, November 2006). In the following sections, I present the data on Hannah and how she changed over time.

Instructional Practices over Time

All of Hannah’s teaching occurred in the same rural school for the three observations. The following sections detail her instructional practices over the three years.

Observation 1

Observation 1, May 2005. This algebra 1 lesson occurred in a class composed of four males and 12 females. All students were white. The focus of this lesson was to teach the students “another method for solving quadratic equations. Just a general factoring technique. We had learned how to interpret graphs and how to use the quadratic formula previously, so just giving them a third technique to solve a quadratic equation” (interview, May 2005).

Her first year observation data was missing so this section appears abbreviated in comparison. However, the interview data was informative and here is how Hannah described her instructional practice for the first observation. She said,

It was mostly me working the problems, which is not always the best. A lot of times we get out the dry erase boards, and I have them work the problems and then I can walk around and see, which I didn’t get to do. (interview, May 2005)

This statement makes it clear that Hannah spent a significant portion of the lesson demonstrating how to do exercises by using a lecture format. She indicated another

strategy utilizing white boards, but did not elaborate. Based on this data, I classified this lesson as a Lecture.

Observation 2

Observation 2, February 2006. This is the same rural school as the previous year. This tenth grade geometry class comprised two males and eleven females, all white except for one exchange student from South Korea. The content of this lesson is an investigation into the quadrilateral called a kite, including the use of a protractor for angle measurements.

Pedagogy. Hannah's teaching for the second observation was classified as Group Work/Lecture. In the following paragraphs, I describe the basis for this classification.

Hannah began class by saying, "today we will learn about a quadrilateral we haven't talked about before. The kite." She then asked the class, "What does convex mean?" About 6 female students begin talking all at once. Somewhere in all of this talk the teacher gathered an acceptable definition for what convex means. She then went to the board and wrote: "Kite: a convex quadrilateral that has 2 pairs of congruent sides, but no pair of opposite sides is congruent." With this she said, "We are going to do some cooperative learning, so get into groups of 2 or 3" (observation, February 2006).

The cooperative learning activity ensued, and all groups were 2 students except for one group of 3. The teacher distributed yarn, straws, and protractors to each group. The activity was to string the yarn through the straws in such a way as to create a kite, and still have enough yarn left sticking out of two corners so that the students could make an "X" with the yarn to form diagonals. During this segment, everyone stayed on task. When one group finished, Hannah held it up as a model for the other students to observe. The second part of the activity was for the students to measure the angles that the

diagonals formed. The teacher went to one group and told them to measure “this angle, then this one, then this one” pointing to two corners of the kite and one of the angles in the middle formed by the diagonals. The students then measured angles with a protractor (observation, February 2006).

The teacher had the groups report out their measurements, and one group realized that they were not measuring correctly with the protractor (see Culture section for additional details).

Beginning the lecture phase of her lesson, the teacher then went to the board and wrote, “Diagonals of special quadrilaterals:

- diagonals are perpendicular
- diagonals of a rectangle are congruent”

The teacher discussed these properties of a kite, but no input from the students. Then she drew a coordinate plane on the board and located 4 points, A, B, C, and O. She asked the students to find the coordinates of the missing pieces and asked the class, “What would I need to show AC perpendicular to BO?” She gave the students a brief pause before she told the students to “think about the slope.” Hannah then worked through the problem, and the students did not seem to be following. For instance, she wrote the slope formula on the board, worked it out to the very last step, which was $-S / S$. She broke from her lecture style to ask the students for the answer but they had no answer. She simplified the situation and said, “well, what would -2 over 2 be?” She received incorrect responses, such as “-S” from one student. Hannah and the students got through this problem, and Hannah moved on to another problem, this time she started by writing the distance formula on the board. She drew a diagram of a square with drawn in

diagonals. In this one, she asked students what to do to find JK (a side length) and received more seemingly random, incorrect responses. One student said “square it” another said “square root” and other responses which were incomprehensible due to too many people talking at once (observation, February 2006).

During this lecture, Hannah made attempts at using an IRE format to work through problems. Due to the lack of understanding displayed in the students’ responses, Hannah ended up performing the work alone which kept this part of the lesson under the lecture designation.

Design of the lesson. This lesson was designed to engage students in an investigation of the properties of kites. Hannah made efforts to connect the properties of kites with other quadrilaterals, and also to connect these properties with coordinate geometry. She planned on working through exercises after the initial investigation. Although it appeared to be a plan for an IRE format, the content knowledge of the students prevented the second half of the lesson from being anything more than a lecture of Hannah working out problems.

Content. Properties of quadrilaterals, in particular a kite, are an appropriate study in the course of geometry.

After writing, “Diagonals of special quadrilaterals” and “diagonals are perpendicular; diagonals of a rectangle are congruent,” Hannah discussed the specific properties of a kite, in particular that “only one diagonal is a line of symmetry.” She then continued her lecture by working three problems on the board. The first two she started with were not kites, but rather squares. She drew a coordinate plane on the board and

labeled four points, one is at the origin, one is at $(0,S)$, and the coordinates of B and C were initially blank.

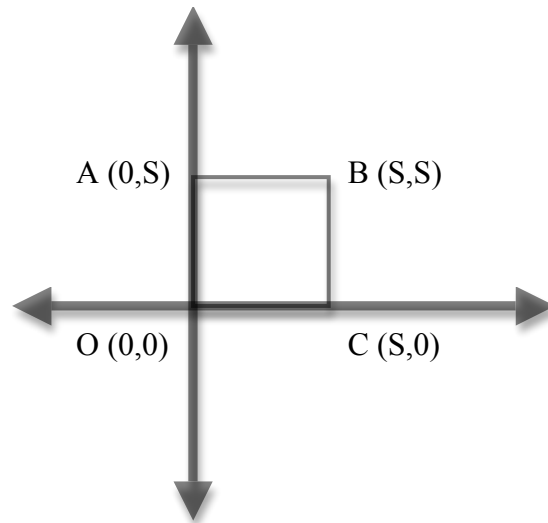


Figure 9. Coordinate plane with the vertices of a square.

She asks the students to find the coordinates of the missing points. She also asked them to tell her what she needed to show that AC was perpendicular to BO, the opposite corners, to show that the diagonals were perpendicular. Without discussing why this was necessary, she provided the students with the formula “slope of AC= $(0-S)/(S-0) = -S/S = -1$.” Before getting to -1 , she asked students what the answer would be. They did not know, and she tried to make an easier problem for them by asking what $-2/2$ would be. Hannah ended up telling the students. Writing the distance formula on the board, the teacher worked out an exercise, this one also dealing with a square and its diagonals, asking to find a measurement that is not given. Once again, the teacher worked the problem out while the students watched. She ended with a kite problem, and a similar series of events occurred as in the previous examples (i.e. she puts the problem on the board and worked them out, the problems had no context, there was limited student interaction).

Culture of the classroom. This class had a large number of girls in class compared to boys. It felt as if it was a honeybee hive, with Hannah as the queen and all of these girls as the worker bees. The teacher did not ignore the boys, but the feminine aspects of the class dominated the mood. For example, shortly after distributing the yarn, protractors, and straws for the activity, Hannah realized that the yarn she gave out was not long enough. She asked the students to unstring what they have done, and she gave out new yarn pieces. While she cuts new yarn at her desk, she talked with some girls about knitting. None of them, including the teacher, knew how to knit. I provide this initial description to describe the congenial mood of the students and teacher in this classroom.

The culture of the classroom was conducive to learning and working with mathematics. The class was initially laid out in rows, but not so straight that it looked as though no one could twist their desk. The students moved their desks together for the activity (observation, February 2006). This cultural construct of furniture movement permitted Hannah to move flexibly between Group Work and Lecture.

There was some mathematical discourse used in the presentation of problems and their solutions. Following the construction of kites using yarn and straws, Hannah had the groups report out the measurements they had made with their protractors. Upon hearing the measurements from other groups, one group said, "I don't think ours is right. How do you measure with a protractor?" The teacher went to their group and quietly helped them. Following this brief interruption, the teacher talked to the class about their findings, the highlight of which was "bisected angles." The teacher also pointed out that a few groups noticed that the diagonals crossed at right angles. Some students related this investigation

to a previous lesson about a rhombus. A small negotiation about similarities of a rhombus and a kite took place, however, the discussion was not coherent enough for observer documentation (observation, February 2006). As this lesson demonstrates, when Hannah was not lecturing, the students carried on mathematical conversations.

Observation 3

Observation 3, November 2006. This algebra 2 class of eleventh graders was comprised of three males and seven females; all students are white except for the exchange student from last year; this was his last day. The lesson was on exploring the “families” of x^2 by graphing several equations on one graph paper.

Pedagogy. Hannah used three distinct formats: IRE, Group Work, and Whole Class Discussion to teach this lesson. In following paragraphs I detail how each of these three segments were used to teach this lesson.

Hannah began the IRE segment of her lesson by graphing $y=2x+2$ on the board. She told the students that they should remember this as a “linear equation”, and then wrote $y=x^2$ on the board. She asked the students if they remembered what this sort of graph was called. The teacher waited and eventually heard “parabola” from some of the students, and “oh yeah” from many others. She then began graphing this equation by plotting one point at a time, requiring input from the class to determine the x and y coordinates for the points. For example, “Plug in 0, what do I get?” she said, with the students saying, “0.” Once she graphed five points in this manner, one student said, “Oh yeah, these are those ‘U’ looking things.” The teacher then asked, “Do you notice it is symmetric?” She also said, “We call this the axis of symmetry, and it is not always on the y-axis.” During this time, about half the students were watching and listening to what she was doing, and the other half were taking notes (observation, November 2006).

To transition into the Group Work phase of the lesson, Hannah had the class split up into groups of two to explore the graph ‘families’ of x^2 . She had graphed the ‘parent’ equation on the board, and the groups were given four different colored pencils for the four graphs they were to construct on one piece of graph paper.

After the groups finished, Hannah led a Whole Class Discussion on the differences between the graphs and the equations. She required the students do most of the talking and describing, as I detail below. She made a connection to previous work they have done with square roots, and to problems investigated by Galileo concerning falling objects. She then gave an assignment from the book and class ended (observation, November 2006).

Following the Group Work, Hannah drew the students’ attention to the front of the classroom. She told the class that they were going to “look at what changes occurred.” The students pointed out that all of the equations had the same vertex point. The teacher said that the graph of $y=1/2x^2$ was “fatter” and asked, “Is that what you would have expected?” One student said that $y=-x^2$ was “flipped down” and Hannah asked, “Can you think of another way you can say that?” The student said, “It is reflected over the x -axis.” In total, the students described all four graphs with the teacher’s prompting. At first, the students used terms like skinnier, fatter, and flipped down, but the teacher pushed them to use the mathematical terms “vertical stretch”, “vertical compression”, and “reflection over the x -axis.” The teacher then related the equation $x^2=4$ with $x=2, -2$. She pointed out that this is where the graph of $y=x^2-4$ crossed the axis. To extend the lesson into a real-life context, she read a problem from the textbook which referred to Galileo’s $d=16t^2$ formula for falling objects. She worked the problem out on

the board with $d=180$ and asked the students if the negative solution to this problem made any sense. The students said “no” because they did not have negative values for time. Hannah told the students that this equation does not account for friction, which would be a factor here on earth. She used a feather catching air to describe the phenomena. Finally, Hannah pointed out that standardized tests sometimes have questions like this, particularly since a person’s intuition may suggest that a feather falls at a different rate than other objects. She then gave an assignment from the book and class ended (observation, November 2006).

Design of the lesson. Hannah intended this lesson as an introduction to graphing quadratics. Her observed lesson matched what she intended the focus to be. She said, The purpose of the lesson was to introduce graphing quadratic equations. Also, how to go from $y = x^2$ to what happens if there’s a number in front of the x , if there’s a coefficient, and what happens if it’s bigger than one or less than one. (interview, November 2006)

Her statement indicates that this lesson was intended to explore the effects of coefficients on a parent equation. Furthermore, her lesson was planned to encourage this exploration, in her words, “Just for them to see what happens to the graph and get a feel for that. It was a basic introduction to graphing quadratic equations” (interview, November 2006). Hannah’s lesson reflected an emphasis on exploration, and the students were observed exploring the families of a quadratic equation.

Hannah had expectations for student misconceptions and planned accordingly. She stated,

Well, I noticed that in the past, just getting them to understand the big picture of other things we've done, like when we do the intercept form to realize that every time they've solved a quadratic equation, whether it was factoring or with a quadratic formula, that those are the x intercepts of the graph, of the parabola. I think that's one of the hardest things about math. You learn how to factor, and then one or two or three years later you learn how to graph the quadratic and you just never make the connection between the two.

Hannah made efforts within the lesson to connect the graphing of quadratics with other areas of mathematics. She started with a comparison to a linear graph, and then structured her lesson to investigate the families of graphs. She concluded by connecting the day's studies to Galileo's equation for falling objects.

Finally, Hannah expressed how she came to expect these difficulties. She stated, I know from my personal experience that I found it hard to sometimes connect math. Things that I've learned in one content area to other things. And then, also from the last two years of teaching. Just watching how they read and think things through. (interview, November 2006)

In her third year, Hannah showed that she was getting a feel for the concepts and connections the students struggled with and made plans accordingly.

Content. This lesson was on families of parabolas with connections to domain and range. Hannah worked from linear to quadratic to introduce the concept of parabolas. She graphed the linear equation $y=2x+2$ followed by $y=x^2$. She graphed five points on the x^2 equation, making sure that students were following each step in the process by requiring them to provide the y-coordinates. Evidence that her strategy was effective was shown

with one student's verbal exclamation "Oh yeah, these are those 'U' looking things." This showed that at least one student had time to think about this graph and recall previous knowledge. Hannah asked the students to look for symmetry and pointed out that not all parabolas have symmetry on the y -axis. She then led the students in an analysis of the Domain and Range of this graph. For the domain, the teacher wrote " \mathbb{R} s" and said, "I use this shortcut for all real numbers." Although she told them what the domain was, she asked the students for the range, and the students said that the graph "is never negative." Without further student input, the teacher wrote "Pos \mathbb{R} s" and said, "positive reals."

During the Group Work segment, Hannah had the groups explore the graph 'families' of x^2 . She had graphed this 'parent' equation on the board, and the groups were given four different colored pencils for the four graphs they were to construct (on the same piece of graph paper). The teacher used x^2 as the parent graph and assigned the students to graph $y=x^2$, $y=2x^2$, $y=1/2x^2$, and $y=-x^2$. She instructed the students to draw the graphs each in a different color "so you can see what happens." She also required that each person in the group should graph two of the four equations. The students began working and occasionally asked the teacher for confirmation. Some students using calculators encountered a problem when they put in -1^2 and got -1 . They asked the teacher for help and she asked them what -1 times -1 was. She pointed out that they needed to use parentheses to include the negative in the squaring function.

Hannah connected the lesson to other areas of mathematics as well as other subjects. For example, during the Whole Class Discussion, she focused the conversation

on how the graphs compared with the parent graph and required students to use mathematical terms in their verbal comparisons.

Culture of the classroom. The first three minutes of the period provided an example of how the students and teacher communicated with one another. The period began with the teacher telling the students what was for lunch. A conversation about submarine sandwiches took place, in which a student admitted to not knowing that a sub sandwich was a submarine sandwich. The students involved in this conversation did not interrupt one another, everyone seemed to be friends, and there was no making fun of one another or teasing. The teacher and students smiled a lot during this time, and they laughed some. They discussed the animal crackers that they would eat at lunch. The teacher had a brief, private discussion with one student. The class quieted down without Hannah saying anything, and she started the lesson.

The culture was also conducive to learning and working with mathematics. During the Group Work segment, the students talked with each other, and sometimes disagreed. One student was overheard saying, “I told you. I shouldn’t have listened to you.” This was said in a way that was not disrespectful, but rather where a consensus was reached within the group but later had to be adjusted. Another pair was overheard with one saying, “Yes, yes. I see what you’re saying now. Okay!” During this time, the teacher walked around monitoring the groups. She offered help to one group, saying, “I always have to make an X-Y table. If you can do it without, go ahead.”

In this lesson, there was a focus on congenial relationships and a focus on mathematics. The students and teacher had established a culture that permitted a small bit of off-topic discussion before the lesson started, and then required mathematical

conversations from then on. There were no management issues during the lesson. As recorded in the content section, students freely offered comparisons of families of graphs and were open to Hannah’s insistence of using the proper vocabulary in their descriptions.

Within-Case Analysis

Hannah’s scores on the Horizon Protocol instrument for the three years of observation are displayed in the following table.

Table 20

Hannah's Horizon observation protocol scores

Observation	Design of the Lesson	Pedagogy	Content	Culture of the Classroom	Summary
May 2005	3	4	3	3	3, low
November 2005	4	3	4	3	3, high
October 2006	5	4	5	5	4

Pedagogy. Hannah’s pedagogy evolved steadily over the three years. Her initial year, although without observational data, was a lecture. In her second observation, she utilized a lecture for the second part of the lesson, although it appeared that she was trying to gather student input. There were, however, some other interesting findings in her pedagogy from the second observation to the third that arose during the analysis. First, Hannah seemed to employ group work as a routine part of her lessons. In the second and third observations, Hannah had students work in groups of two. During the third observation, she had well-defined instructions for each student in the group. She also transitioned into the Group Work segments differently from year to year. The lesson

from the second observation almost started with the group activity, with only a minimal introduction. The lesson from the third observation incorporated an IRE format introduction to the topic of the day, an introduction she had not used in the second observation.

After each of these Group Work segments, Hannah followed with a discussion. In the second observation, she opened her discussion by writing a bulleted list on the board of properties students needed to know. This teacher-directed discussion left many students wondering what the teacher was doing and why. Because her students were not following the explanation, her attempts at using an IRE instructional format reverted to a lecture. However, in the third observation, she opened a Whole Class Discussion with the invitation to “look at what changes occurred.” During this discussion, students were required to speak, and Hannah served to push their thinking and vocabulary. The students did not seem lost in the third observation as they did during the second observation.

Over the three-year period, we see Hannah honing her skills in teaching. Her first year’s instructional practices seemed to be a coping mechanism for being the only math teacher in the building and having multiple courses to prepare for. Her acknowledgement that this was not the best way to teach foreshadowed a change in teaching style. The second observation documented a change in instructional practice, but also that Hannah was incorporating multiple practices. Several lessons in this study incorporated Group Work, but Hannah followed this with an attempt at a teacher-led discussion. Finally, her third year lesson revealed that Hannah had accomplished an instructional repertoire that allowed her to use three different strategies in one lesson. She used IRE to introduce the topic, Group Work for a student exploration time, and a Whole Class Discussion for a

summary. The students seemed very familiar with this format, a further indication that Hannah utilized this practice when she was not being observed.

Design. In each of the second two lessons, Hannah planned an exploratory hands-on work time and a wrap up. The second observation revealed a lecture that Hannah intended to be IRE. Perhaps the students' heavy dependence on the teacher kept them from being able to participate in this exchange, leaving Hannah to employ a lecture. The third observation makes for good comparison with statements Hannah made during her first interview. Recall her words "I'm really hoping that I can do less direct instruction and it just takes time for me to develop those plans" (interview, May 2005). The third year observation data reveal that Hannah had found the time to create lessons that incorporated appropriate introductions, exploratory time, and summaries that incorporated the students. In her third interview, she expressed how she had come to know what to expect. In her own words, "From the last two years of teaching. Just watching how they read and think things through" (interview, November 2006).

Besides the exploratory hands-on time and wrap up, Hannah had designed her lessons with a focus on connection. Hannah made explicit attempts to connect her lessons with previous content. Her attempts were not always successful. In her second observation, Hannah attempted to connect the concepts of kites with other quadrilaterals. She was not explicit in what she was doing, particularly when she used the slope formula to show that two sides of a square were perpendicular, and the students were unable to follow along.

Content. Throughout the observations, there is a gradual transition of ownership of content from Hannah to her students. The first year, content was solely in Hannah's

control. However, Hannah began to make efforts in the second year to allow for student input. Her use of students making models of kites in the second observation, and her use of IRE instruction in the third observation reveal that Hannah was putting more responsibility on the students for thinking and speaking mathematically.

Furthermore, Hannah utilized instructional strategies in the second and third observations to facilitate student understanding of content. In the second observation, Hannah had the students build models for illustration and measurement. In the third observation, Hannah required students to graph families of functions on one piece of graph paper, using different colors for each function.

Culture of the classroom. The classroom culture over the years seemed to grow in quality. Hannah had established herself at the school as a permanent fixture having been the junior class sponsor and academic bowl coach (interview, May 2005). Students knew her well, and she was able to converse with students about personal issues, such as submarine sandwiches and knitting, as well as mathematical issues, such as angle measurements and graphing. She was never observed as having issues with classroom management. By the third observation, Hannah had effective control in transitioning between various instructional strategies within one class period. In both the second and third observations, students worked in pairs. Groups that discovered problems did not hide these from the rest of class, but freely admitted a need for assistance or a change in strategy. Students knew to move their desks together for Group Work time without being instructed, and students stayed on task while working together.

In terms of mathematical *authority*, Hannah began with complete authority in her lecture during the first year. The second two years reveal a change in the authority, as

Hannah moved to multiple instructional formats during her lessons. The second year, Hannah allowed the students time to work together during which time they were allowed to discuss the activity with themselves. However, Hannah was still viewed as the primary authority. This was illustrated when students had difficulties and they would ask her if between one another they could not find the answer. The third year, however, revealed a shift in mathematical authority when Hannah engaged the class in a Whole Class Discussion. During this discussion, she frequently deferred questions students asked back to the class.

These four case study teachers provided an in-depth look at the instructional practices of four categories of teachers: *Unchanging*, *Traditional to Non-traditional*, *Non-traditional to Traditional*, and *Adjusting an Ever-changing Instructional Style*. The *Unchanging* group was by far the largest group of teachers, which suggests that a majority of teachers will teach with one particular style most of the time. It is no surprise then that the traditional IRE style and the somewhat related Lecture style were the prevalent style for those teachers observed as having made no significant changes in instruction.

To conclude this section, I offer the following assertion:

Assertion 3: The alternatively certified teachers in this study generally chose one instructional style and continued to use it.

Associated Contextual Factors of the Case Study Teachers

In this final section, I present the analysis of the interviews from the four case study teachers. In chapter 2, Figure 2 was presented as a framework for studying the factors that the research literature suggests are relevant to instructional practices. In the

following sections, the findings from the analysis of interview data are presented with sections for the factors of: Certification Program, School Context, Professional Development, Knowledge of Teaching, and Beliefs.

Certification program includes any factors in the interview data that reveal how the certification program influenced the instructional practices of the teachers. Some of the factors include individual courses that were helpful, themes that were integrated within many of the courses, professors that were particularly helpful, and support structures such as classroom visits by professors.

School context includes a range of factors such as the support offered in terms of other teachers (including mathematics teachers), content coaches, mentors, technology, and school culture.

Professional development includes both what the school offered and other offerings outside of the school. Examples included teacher work days, seminars offered before/after school, regional, and state meetings.

Knowledge of teaching encompasses a range of characteristics. Some of these include how a teacher improves his or her instructional repertoire, and the factors that influence their instructional, curriculum and assessment decisions.

Beliefs is a category that focuses on factors that arise out of the interview data. Some factors are beliefs about student knowledge, the role of testing, the involvement of the community, student motivation, and the value of teaching.

Finally, support structures is a general category that typically contains other areas of support not directly covered in the previous sections.

As with many interviews, some yielded more information in particular areas than others. I begin with Talat, the teacher representing the *Unchanging* category of teachers.

Talat

Certification Program

Talat found his teacher certification program after already having been accepted into another certification program. The program he withdrew from required taking classes in the daytime, and he needed to work (as a teacher) during that time. The program he completed his certification in allowed him to teach and work toward certification.

Talat enjoyed his certification program because he was teaching when he entered, and so he had experiences to draw from in his courses. He said that his program was able to fill in gaps in his teaching knowledge.

When courses in his program focused on practical ways of working with kids, Talat would say that he tried it and it did not work. However, when the course discussions were theoretical, he said that these bored “him to death” (interview, October 2004).

He said that the certification program broadened his views of the teaching experience. He was surprised at how much the experiences of others in the program differed. The program also helped him acclimate to Missouri and learn some of the educational policies with which he was not familiar. Having a network of people “in the same boat” as he was in was the most valuable part of the program (interview, October 2004). A year later, he still talked of networking as his top value in his certification program. When discussing the most valuable aspects of the program, Talat stated, “Just getting different ideas, getting different contacts, and also networking with other people

in my position, has been the most helpful part of it” (interview, November 2005). He continued about the value of the contacts outside of his school stating,

We email back and forth to specific people sometimes, or if I see them around town or if I have a specific question, I can contact them. Say they presented a lesson, you know, I needed some idea, we’ve contacted each other on that too. (interview, November 2005)

These excerpts illustrate Talat’s view of his certification program. He never mentioned the professors, courses, or any aspects outside of the networking he maintained. His language did not suggest that these networks were an overt structure of the certification program, but rather a spontaneous bonding that occurred between Talat and his classmates.

School Context

His first school hired him for his ability to coach first, and his willingness to teach mathematics second. This school offered substantive professional development, which is discussed in a section below. Talat summarized the school culture, “a lot of our teaching staff have determined that our kids are more of the ‘tell them and then have them reproduce,’” type of students (interview, October 2004). Talat adopted this view as shown in his first year observation. He defended these views by citing that the poverty, drugs, broken families, and apathetic parents were to blame.

For two reasons Talat changed schools after his second year teaching. One was his recent marriage and, second, the need to move to a closer location to the university to complete his certification program. The other was the report of being “ready for a change” (interview, November 2005). Talat said that his first school was becoming repetitive and would stick him in a rut. Having taught under an emergency certificate, he

wanted “to try some different things, see some different things, learn from different people, and be around different groups of students” (interview, November 2005). He reported his school the first year was just trying to survive.

His new school had students who “desire to go to college, for the most part, the desire to do well” and “the community support is different, for education first and athletics at the same time, and just having overall student success” (interview, November 2005). His new school was not trying to survive, but rather, “here it’s trying to get our students the best” (interview, November 2005).

Professional Development

His first school offered substantial professional development, but not in mathematics. He attended many seminars about “based on our migrant Hispanic population” as well as “language training” and training for “collaborative teams” the teachers were involved in (interview, October 2004). Furthermore, he attended two conferences during the first year, “One on teaching reading across the curriculum and also one on teaching preparing students for the ACT exam” (interview, October 2004). Others he discussed were sessions developed to assist teachers in adhering to FERPA guidelines, gun policies, and sexual harassment.

Talat had two mentors in his first year, one who was assigned to him from outside the district through the *Transition to Teaching Project*, and another from within the district. The *Transition to Teaching Project* was described by Talat as a program operated, “in conjunction with the state for teachers in alternative certifications who choose to go through a ‘Transitions to Teaching’ class which are assigned a mentor for two years outside of their school district to come in and help them” (interview, October 2004). This mentor met with him once a month with a set of formal issues to discuss. She

was also available to Talat by email and visited his class about once a month. During these visits they would “sit down and discuss issues she brings like materials for me to look at, and she also observes usually part of one of the classes that I teach” (interview, October 2004).

His mentor within the school was of limited value. Talat stated that this mentor was, “another teacher who is also the athletic director. He doesn’t have a lot of time to come and just sit and just work in my classroom. It’s more of the informal sit and talk if we get a chance” (interview, October 2004).

Knowledge of Teaching

With Talat, he seemed to rely on his own personality in motivating students to learn, and used his knowledge of the standardized tests to structure his curriculum.

Talat said that applying behaviorist theory to instruction did not work with his students and that finding a motivator for students was difficult. Talat reported that, “90% of teaching is personality and 10% is content” (interview, October 2004). In light of his difficulty motivating students and his view of teaching, Talat appeared limited in his knowledge for teaching.

Talat recognized the importance of looking through the curriculum ahead of time and choosing what to include, what to skip, and what sequence to go in. He said, “Some of these topics I’ve taught three different ways, just trying to find the one where they get it the best, you know, or get it a little better, I guess not the best” and talked further about keeping what has worked and trying new ways on things that did not go so well (interview, November 2005). In this sense, Talat was willing to try different things, but his observations suggested that he used different ways of showing students how to solve

math problems, but followed a similar instructional style by teaching and instructing through a lecture format.

Talat used tests, such as the state assessment and ACT, as sources to determine what to teach and how to sequence instructional units. He stated,

Just being able to look at it as far as how I organize classes, and what order I teach things, and what I use out of the book and what I don't use out of the book. A lot of that comes from experience, too. Seeing what's really important in the end and what's not as important. Especially in my Algebra II class, where there are so many different topics and so many different concepts within those topics, what I've done is pulled from past experiences and seeing what the students need to have to be successful in the class; meeting the requirements for the ACT, meeting the requirements of [the state] testing, and so on. Really pulling from personal experience as far as what I've seen before as in not only what do I teach, but how do I teach that. (interview, November 2005)

Talat did not specifically describe how state assessments informed his instruction, other than by providing a list of topics to cover and types of problems to present to students. Because he seemed to use these tests as a curriculum guide, he was asked if adherence to these tests was restricting. He replied,

No, not really. I don't find (state assessments and the ACT) restrictive. I find (them) guiding, as far as what should I teach, what's important. But, at the same time, I don't go wholly on, this is on the ACT so we only teach that. You know, I teach a lot of things, I just reorder to make students more successful. Because if we're to be teaching what we're teaching now in the Spring they'll have taken the

ACT by then and not have had what they needed for it. I use it as a guideline sometimes, but I don't find it restricting by any means because most of the stuff on the ACT tests is what they needed to go on to college anyway. (interview, November 2005)

Beliefs

Talat said that although he should believe that 'every kid can be reached' that he still found that "some . . . have absolutely no interest in ever giving a concern in my class" (interview, October 2004). He cited "external factors" that he could not control. One factor was that, "I've got three or four examples of kids in my classrooms that I don't know what you could do to get them to really be concerned about their grades, to really be concerned about behaving in class" (interview, October 2004). Talat primarily viewed student performance through the lens of student grades and student behavior.

Talat believed that in teaching he provided a service to the children, parents, and the world. He said, "It's because I'm doing those kids a service, I'm doing their parents a service, and I'm doing the world a service, by doing what I'm doing" (interview, October 2004).

Talat believed that through personal reflection on successes and failures, where kids did well and where they had trouble, had the effect of making a person a better teacher. When asked during his second year teaching if he found that his experiences in his school the first year were helping him, he stated, "You can't help but become a better teacher when you get more experience. So I look at where successes and failures were last year, where do the kids really take off on, what do the kids really struggle with" (interview, November 2005).

In his new school, Talat believed students were lacking due to the previous curriculum they had the year before and felt a need to “get them up to speed” (Y2 interview).

Support Structures

Talat relied on teachers with more experience, both within and outside his school. He frequently communicated with teachers whom he had worked with in the past, as well as other teachers from his cohort in his certification program. His new school assigned him the only other math teacher as his mentor. He reported that the principal checked on him and wanted to make sure he has everything he needed to teach how he wanted.

Kanak

Certification Program

Initially Kanak enrolled in the ATCP route that allowed for a year long internship, but during the summer a school district principal offered her a job and she began teaching in the fall. In her first interview, she regretted the decision stating, “About halfway through the year, I think, ‘Gee, I wish I had interned instead of taught’” (interview, March 2005).

She said that most of the program was more “about research and the current learning theories and more general information than anything that’s directly applicable” (interview, March 2005) to her teaching.

By the third year, Kanak reported that the program was excellent, and she said that in comparison to the other degrees she had earned in her life that she believed this program was excellent. Specifically she stated, “The quality of the teachers, the quality of the instruction, it is excellent” (interview, September 2006). She reported that the most useful part of the program were the classes on child development and psychology. She

said that when she was substitute teaching that she used to take students' behavior issues personally and blame it on various reasons but that the courses helped her understand "that most of children's behavior is driven by children's needs, as opposed to just by bad upbringing or things you can't do anything about. You can do something about their needs" (interview, September 2006).

School Context

Kanak's classes were small, although she had several classes to prepare for. In the third year, Kanak reported having "very little oversight" and that she did what she wanted. She tried to use the GLE's and the diocesan curriculum, but no one evaluated her based on her adherence to either. She said plainly, "I can go back over stuff – if I decide I need to spend three more weeks doing fractions, we spend three more weeks doing fractions" (interview, September 2006).

Professional Development

Kanak not only taught in a school with minimal content support, but also one with few resources for content-specific professional development. Kanak received what she called "generic" professional development and said,

They'll never pay for me to go to the NCTM conference or anything like that, which would be nice. That won't happen here. Since I'm the only math teacher, there is no math group to go to a math professional development or something" (interview, September 2006).

This statement reflected her lack of professional development, as well as showed that this was an element in her career that she felt a need for.

Knowledge of Teaching

Despite the observed classes in her second and third year, she reported that the program conveyed to her that:

the whole idea being more toward discovery and helping the kids to think for themselves, because my textbooks were fairly traditional. (The textbook is designed), ‘page 1, algorithm 1, page 2, algorithm 2, page 3, algorithm 3.’ And (my teacher development program has) helped me step beyond them and try to find ways to, hopefully, enrich their learning experience, as opposed to just cranking through a bunch of different calculations and hoping they memorized all of the procedures.” (interview, September 2006)

Beliefs

Kanak believed that kids should learn in a meaningful way, but did not follow through with these beliefs in her lessons. She talked a lot about “memorizing” and “practicing” being less desirable, but in her lessons this is what was observed during the second and third years.

Support Structures

Kanak’s first lesson revealed a lesson that made use of hands-on learning that involved all of the students in a group project. This instructional format was not observed in the following years. Kanak admitted that her certification program required the teaching a lesson as part of an assignment, and that the observed lesson was planned to meet the requirements of her program. This partly explains why her first lesson differed from the lessons in the following years.

However, Kanak felt supported at her school stating, “It’s just such a small environment it’s almost like a family environment” (interview, September 2006). As

evidenced in the previous categories, this “family” environment did not provide her with the content-specific support for her as a mathematics teacher.

Ava

Certification Program

Ava’s certification program encouraged her natural tendency of being organized by preparing her for teaching several different subjects. She found her certification program supportive through the classroom visits conducted by one of her professors from the university. Ava was able to incorporate many of the ideas this professor suggested at these visits, and was able to modify her teaching strategies as a result. This content-specific support aided in Ava’s growth over the first two years of her career.

School Context

In an interview, Ava responded, “Yeah, I love it!” when asked if she was satisfied with her job. She said, “I like the school. I like the faculty. I like the students” (interview, October 2006). She reported a desire to stay in teaching until retirement, and her only desire was to get a job in a school closer to her home due to a lengthy commute. However, she loved the school so much that she and her family had been looking for a house closer to her present school.

Because the school was small, one computer lab existed in the building. Ava recognized this as a weakness of the school, but she made adaptations to her technology demands by making more use of calculators and working with other teachers in scheduling the only computer lab.

The school administration supported the alternative certification program Ava attended and had hired several people, from teachers to counselors, that were currently working toward full certification at the same university.

Professional Development

Ava did not discuss professional development opportunities outside her certification program in her interviews.

Knowledge of Teaching

By the third year, Ava had taken elements of her preparation program (classroom visits from a university professor, organizational elements learned in courses) and created a classroom situation that worked for her. In the first two interviews, she described her preference of having students work in pairs, as well as her rationale for not having them work in threes. To accommodate groups larger than two, she assigned roles to each person in the group to hold students accountable for learning and working.

Beliefs

She believed that being an active member of a small community was necessary so that the local people would see that “she does care” (interview, October 2006). Because she was a familiar face to many of the students’ parents, and within the community, she felt she had established an additional level of trust.

During instruction, Ava taught students computations by hand first, and followed this with technology. An example of this occurred with her unit on matrix operations. Instead of teaching them how to use the technology, she required the students to produce the procedure, which would then be shared with others using the calculators. She

believed this sharing was important enough that she made copies of these procedures for all of her students.

Ava did not view high-stakes tests, such as the ACT, as resources to be consulted in curriculum articulation. Even for a week before the test date, Ava continued following the district curriculum and the state standards.

Support Structures

Ava's mentor was her first source of help for questions concerning teaching practice. Her mentor was also someone she worked with on non-academic matters such as sharing the junior class sponsorship and working at the concession stand together. Ava was comfortable going to the principal for help in the event that her mentor was not available. Ava expressed being willing to talk to the superintendent, but only if the other avenues were not available and if the issue was appropriate, in particular, issues concerning NCLB.

Ava also reported developing support from parents. She reported how she immersed herself in the community and by her third year was well known by parents and community members. Students knew that Ava was likely to call parents or even "stop at [a student's] house" (interview, October 2006). Ava believed that to function in a small community school required embracing the culture and being involved. Ava did this to a high degree and felt supported at the community level.

Hannah

Certification Program

Hannah spoke highly of her program, but lamented the lack of field-based internship opportunities. She said, "Still, in this kind of a program, when you start

teaching you don't have very much teaching experience at all. You don't do student teaching, you just start right in. So that's kind of hard" (interview, November 2006).

She went on to discuss the lack of a methods course for mathematics. She also wished to have more experiences with math teachers especially to see how different people taught. Hannah did take the initiative to enroll herself in a field-based practicum. This was beyond the requirements of her program but was suggested as a possibility by one of her professors. She said, "Well, it was through one of my classes, that the idea came to me, and they were definitely supportive but they don't try to hook you up with anyone or anything" (interview, November 2006).

School Context

Although Hannah was satisfied with her job, she found the small school difficult for various reasons. She stated,

It is hard to teach in a small school. Sometimes it's overwhelming. The fact that I don't have other math teachers to talk to about how to approach things or different ideas at school. I have other math teachers I could talk to, just not at school. And then, there is a lot of pressure with MAP testing. Sometimes I think whether I get tenure or not will be solely based on those math scores. (interview, November 2006)

This concern over test scores was substantial because she was the only math teacher. However, she her students produced strong state test scores through the third observation. She stated that her evaluations had all been good, and that the scores from the past years were high. But she stated,

But, I'm afraid if the scores don't stay high, if I had a bad year or so, that that would kind of be the end of it. I don't know, I might be over-exaggerating, but I'm the only one they could blame in that situation since I'm the only math teacher. (interview, November 2006)

Hannah reported feeling supported by her principal, and having previously received good evaluations, her concerns seem related to the high-stakes views of the state test rather than an adverse environment.

Professional Development

Hannah was generally isolated in terms of building her content knowledge, but she had found three avenues to build her professionally. One was a regional group of math teachers that met occasionally. Another was the state affiliate of the NCTM, which had an annual meeting she attended. Finally, she was involved in a summer institute for new teachers. Hannah said,

I do talk to other math teachers and that's really helpful. I just don't get to do it very often. We have a meeting once a year with all of the math teachers in our league. And I try to go to the local southwest Missouri math teachers meetings. I haven't always been able to go, but I'd like to go to that. But mostly at conferences, when I go to MCTM and I told you about that summer institute I did, and we're going to meet this weekend again. (interview, November 2006)

Hannah was one of the most active teachers in terms of professional development from within the four case study teachers.

Knowledge of Teaching

Hannah found that her knowledge of teaching had grown over the years from different experiences she had. One of these was parenting. Other experiences with teaching did not happen to her until after she had her own children. Hannah reported teaching Sunday school and working with Girl Scouts as two educational experiences that influenced her. Specifically about parenting she stated,

It definitely helps me to relate to other parents when they have concerns about their children, and I think overall it helps me to be more patient, because a lot of the behavior I see at school, sometimes I see it in my own children, and I understand whether it's developmental. It helps me to understand what they're experiencing and things like that (interview, November 2006).

This knowledge from parenting echoed some of the things she learned in her certification program, which served to confirm her experiences in terms of development.

Hannah also gained teaching knowledge from her certification program in other aspects. One was not a course, but a theme that was integrated throughout the coursework. She said she got,

A good understanding of how to get your students actively involved in your learning and why that's important to do. It was emphasized in all of my education classes. And how to write a lesson plan, that kind of thing was really good, how to write tests, and how to develop the unit.

Hannah's observations show that she was able to take this knowledge of teaching and apply it during her lessons.

Beliefs

Hannah believed that teaching should be more hands-on. She said, “I’ve had a hard time trying to apply it this year, but I think as I get more experience teaching and more time, I can do it more” (interview, May 2005). Her first year Hannah employed lecture, but as seen in her second and third observations, she had begun to integrate the hands-on experiences she said were important.

Hannah found that as the only math teacher, she had a lot of freedom. This also gave her a lot to prepare for. She said,

“Well, I have the freedom to do anything I wish. I try to apply it as much as I can. The only thing that deters me is that you have six preps. Sometimes I can’t put as much effort into developing something a lesson that has a lot of hands-on or small groups because I have so many lessons to prepare every day. That’s the only thing that keeps me really from doing that as much as I would like to.”

(interview, November 2006)

Hannah was able to combine her freedom with what she had been taught in her program. In her second two observations, Hannah was seen employing instructional practices that required students to spend time doing hands-on learning.

Support Structures

Despite having a lot of different classes to teach, Hannah was able to manage partly because the class size was small and the administration was supportive.

I love my classes that are small and I love the way that I can develop good relationships with my students. And you get really attached to them because you know them so well after you have them in class for several years. I love that part

and I like the community a lot. I like the administration and it's supportive. I feel like it's a good working environment overall, definitely. (interview, November 2006)

However, working in a small school also had its disadvantages for Hannah. One was that her mentor in her first year was not a math teacher. Also, during different seasons, Hannah was required to fill many different roles, as well. She discussed how these roles affected her and others, including her mentor teacher the first year,

In a small school, everyone is so overloaded. I mean, not only do I teach six classes, but I'm junior class sponsor and academic bowl coach. And everyone is like that, so my mentor doesn't really have a lot of time. I know it's a common problem, and I think when you have a bigger school and you have a math team and all different people that would come in a watch you teach. I haven't had that. I mean, I have my supervisor at [my alternative certification program], and the principal of course. But, you know, my mentor doesn't want to help because he doesn't feel like he can help me be a better math teacher. So, it's been good overall. (interview, May 2005)

Hannah seemed to deal well with this high demand on her time and abilities. She went on about the support level she felt stating,

I feel very supported. When I have needs or if I have problems, I feel like I can talk to several different people and get a really good resolution to whatever the issue is, whether it's with students or parents or whatever it is. I feel very good about that. If I have an issue, of course you talk to other teachers about things that

are going on. But if I need to, I talk to the principal about anything I'm concerned about. He's always been really supportive. (interview, November 2006)

These demands seemed high. However, Hannah reported that she would be working there again as long as they asked her to stay on.

Across Case Analysis

This section highlights the interview data, revealing the factors contributing to changes in instructional practices for the four case study teachers.

Certification Program

Talat seemed to take little from his teacher preparation program other than developing a network of people whom he could share teaching ideas. He found that his teacher preparation courses offered few practical applications for his classroom, and the theories he studied were not interesting to him. He maintained this view throughout the three-year study. Kanak had similar complaints early in her career as a teacher about the theories she learned in her coursework, but later came to realize their value. Ava, on the other hand, found a program that reinforced her personal characteristics (e.g., organization) and provided her with in-classroom support through observations by university professors. Hannah thought that her program did not offer enough field-based experiences, and by her own initiative created opportunities for herself to improve her experience.

This analysis reveals that both certification programs and the people enrolled in them play an active role in the ultimate success or failure of the program. Talat and Kanak both attended the same certification program. While Talat and Kanak initially found the theories espoused in the certification program of little value, later Kanak would

recognized the importance of theory. However, Talat never reached that conclusion. This shows that oftentimes the students in these programs must have an attitude of openness in order for the curriculum to be effective. Ava and Hannah were in two different programs, and both had positive experiences although for different reasons. Ava's program offered the support she needed to modify her teaching practices by visiting her in her classroom. Ava's program had a practical focus on organization that fit Ava's personality. Hannah made efforts of her own to gain further experiences.

School Context

Talat and Ava are illustrative of the power of school context. Talat found his first school to be one that viewed students as incapable and needing everything done for them. Talat moved to a new school where the school culture was focused on excellence. Ava initially liked her school, but the distant commute was a deterring factor. However, the school culture was so positive, Ava and her family eventually considered moving to be nearer to her school of employment. This shows how a school's context can influence whether or not a teacher stays or leaves.

Kanak and Hannah were both the only mathematics teachers in their schools. Hannah's school was supportive, but focused on state test scores as the reason for keeping her from year to year. Kanak did not have this situation, but rather had considerable freedom. She followed her curriculum and made adjustments as she saw fit. No formal evaluation was provided as part of her position.

Professional Development

Talat and Kanak both reported having access to professional development of a general nature. Kanak indicated she had no access for participation in a mathematics-

specific professional development program or seminar. Talat's closest mathematics-specific professional development was his training in preparing students to take the ACT. This test is not solely focused on mathematics, but Talat reported using his knowledge of the ACT to structure his curriculum. Hannah took initiative to involve herself in three distinct professional development programs, two of which were focused on mathematics teaching and learning. Her involvement required both her efforts and the support of her district. Comparing Hannah to Talat and Kanak reveals a striking finding: Hannah was the teacher who exhibited the widest range of instructional practices, and she was the only teacher who was involved in professional development beyond general topics.

Knowledge of Teaching

Of the four teachers, three found their certification programs to be very influential in terms of their knowledge of teaching. Hannah found that her program's teaching reflected what she had learned from personal experiences. Ava's program influenced her classroom format, and Kanak recognized that strict adherence to a textbook would result in limited learning experiences. Only Talat, the teacher who made no changes in instruction through the three years, spoke only of his own personality as being a motivator, and of standardized tests as his source for curriculum structure. This suggests that the certification programs can have an influence on the teachers' knowledge of teaching.

Beliefs

Two teachers, Hannah and Kanak, revealed certain beliefs about student learning. Hannah believed learning should be hands-on, and Kanak believed learning should be meaningful. Both teachers cited their certification programs as forming part of these

beliefs. This suggests that certification programs influence the beliefs of teachers in how learning occurs best. As revealed in the observations, Kanak did not always teach in a way that reflected her beliefs although Hannah was able to after the first year.

Two other beliefs that emerged were Ava's belief that small communities needed to trust a new teacher, and Talat's view that students were deficient for various reasons. Ava believed that in order to function in a small community, she needed to immerse herself in the community. She became heavily involved in the school and community in response to this belief. Talat viewed students through their grades and their behavior. At his first school, he blamed external factors on poor student performance. At his second school, indicated internal factors (i.e., the curriculum) as the reason for low student grades. This suggests that some teachers have deep-seated views on what is needed to be a good teacher.

Support Structures

In terms of mentoring, two teachers had mathematics teacher mentors and two did not. All reported feeling supported by their principals, and Ava even reported having access to the superintendent if necessary. However, Kanak reported feeling supported, but it seemed to be more in terms of working morale than in curriculum, instruction, or professional development. Ava revealed a layer of support, the community, that was not mentioned by the other three. As previously discussed, Talat had a network of other teachers outside of his school that supported him, but not on a regular basis.

Finally, Kanak and Hannah provide an interesting contrast because they were both in small schools and were the only mathematics teachers in their respective schools. However, Kanak was not supported in content-specific professional development

whereas Hannah was. Ava and Talat had other mathematics teachers to work with, yet Talat maintained a lecture format while teaching whereas Ava used different practices each year.

Overall, this analysis led me to the following assertion:

Assertion 4: The alternatively certified mathematics teachers in this study who made changes in instructional practices were of two types:

- *those who moved toward a traditional style due to a lack of content-specific support; and*
- *those who expanded their instructional repertoire through content-specific support structures.*

CHAPTER 5: SUMMARY, DISCUSSION, AND CONCLUSIONS

In this study, I investigated how teachers in their first years taught mathematics. I specifically targeted teachers from alternative certification programs because they represent a growing subpopulation in the teaching workforce. I analyzed their lessons along four components: lesson design, pedagogy, content, and culture in order to provide a multi-faceted view of what instruction looked like inside the classroom. The overall purpose of this study was to examine the following research questions:

1. What instructional practices do beginning alternatively certified mathematics teachers employ?
2. How do the instructional practices of alternatively certified mathematics teachers change over the first three years of their teaching?
3. What contextual factors influence change in the instructional practices of alternatively certified mathematics teachers?

The balance of this chapter is organized into the following sections: (a) summary of the findings from chapter 4, (b) how these findings relate to the existing research, (c) implications for teaching and research, (d) suggestions for future research, (e) limitations of this study, and (f) a conclusion highlighting the significance of this study.

Summary

Franke, Kazemi, and Battey (2007) called IRE “traditional teaching” in the United States, and while this summary shows a variety of styles, teachers were observed employing either IRE or lecture in 70% of the first-year lessons. Almost half (9 of the 20) of the lessons were coded as IRE, an indication that “traditional teaching” is on the tipping point of giving way to other instructional practices. This finding is aligned with

instructional practices in mathematics classrooms studied nationwide as described in the TIMSS Video Study (Hiebert et al., 2005). I summarized the instructional practices of beginning alternatively certified teachers with the following assertion:

Assertion 1: The alternatively certified mathematics teachers in this study engaged in a variety of instructional practices, but Lecture and IRE were the dominant modes of instruction.

A closer analysis revealed that a quarter (5 of the 20) of the lessons were lecture. Lecture represents a move away from the advocated teaching found in the writings of many researchers and policy organizations (e.g., Kilpatrick, Swafford, & Findell, 2001; Lampert, 2001; NCTM, 2000). Lecture also detracts from other social aspects of a classroom. For instance, even the use of “revoicing” to position students with low social status is not possible when the teacher’s voice is the only voice heard in class (O’Conner & Michaels, 1993). These five lessons represent classes where the culture for learning and working was not effective. Consider the classroom culture as measured by the Horizon Observation Protocol sub-score for classroom culture. The IRE classes averaged 3.4 while the lecture classes averaged 2. This is a large difference, and indicates a difference in the quality of instruction between these two designations.

Given that 70% of the lessons employed IRE or lecture, it is important to note that there was a difference in overall quality between these two styles. Hiebert and Grouws (2007) posit that particular instructional practices should not be the focus, but rather, that the effectiveness of a classroom depends on a focus on becoming efficient in executing skills and developing conceptual understanding. Looking at the Horizon Observation Protocol Summary scores for the IRE and lecture lessons, a difference emerges in the

quality of these lessons. The average IRE lesson score was 2.9, with three of the lessons scoring a '4.' However, the average lecture summary score was 2.4, with no lessons scoring above a '3.' Hiebert and Grouws describe the development of conceptual understanding as a lesson where teachers and students attend explicitly to mathematical concepts and students struggle with important mathematics. Lessons that were scored a '1' or '2' do not fall into this category. Three IRE lessons received a '1' or '2,' and three of the lecture lessons received a '2.' A score of '1' represents a lesson with "Ineffective Instruction" and a '2' is only slightly above that designation with "Elements of Effective Instruction." These data suggest that the quality of Lecture is lower than a level '3,' which is "Beginning Stages of Effective Instruction."

Finally, the other instructional practices were Station Work/Group Work, Student Presentations, and Individual Work. The average Horizon Observation Summary scores for these lessons were: 3.5, 2, and 4.0 respectively. The average classroom culture sub-scores are 4.5, 2.5, and 4.5 respectively. Even though these instructional practices move away from traditional styles that rely solely on the teacher as the mathematical authority, the Student Presentation lessons stood out from this group due to their low scores. Teacher may misinterpret the research and policy suggestions that suggest that students take an active stance in the learning process (e.g. NCTM, 2000) as suggestions for students to teach lessons. Alternatively, a lack of knowledge of classroom management strategies prevented these lessons from receiving higher scores on their effectiveness. Either way, these innovative, non-traditional instructional practices are higher in ratings than the IRE and lecture formats, however, there are few of these in each group. I summarized these findings with the following assertion:

Assertion 2: These teachers used non-traditional instructional formats but the lessons varied considerably in quality.

This concludes the summary of the first year instructional practices of alternatively certified mathematics teachers. I now summarize the findings of the analysis of all three years of data as I seek to answer the research questions related to changes in instructional practice over time.

Analysis of the teachers over three years revealed four categories of change: *Unchanging, Non-traditional to Traditional, Traditional to Non-traditional, and Adjusting an Ever-changing Instructional Style*. I chose to use a case study format (Yin, 1994) to illustrate how the teachers in each category taught. I presented Talat, Kanak, Ava, and Hannah to represent the aforementioned categories, respectively.

It is important to recognize that the designations of instructional practice represent only a single lesson during each school year. The following sections provide details on each teacher's instructional practice as viewed through the observation framework from Figure 1. I then provide a summary of each of the case study teachers to highlight the four categories and the influence of the factors.

Discussion of the Four Cases

In this section, I provide the background details of each case study teacher and a synopsis of what their case represents. I relate the relevant literature as it pertains to the case study teachers, and when applicable, the teachers they represent.

Talat represents the fourteen teachers who exhibited little change throughout the three years of observation that I classified as *Unchanging*. Talat was a 25-year-old engineering major, and actively pursued a job teaching. His status as a "homecomer"

(Abell, et al., 2006) is clear when he stated, “I went through and finished the [engineering] program anyway because I was close to being finished” (interview, October 2004). During this study, he taught at two different schools.

In his first year, Talat portrayed content as something for individuals to do themselves or have him show them how to do it. Talat seemed to be in control of mathematics and felt it was his role to dispense the knowledge in all three of his observations. This is reminiscent of Arbaugh, Lannin, Jones, and Park-Rogers’ (2006) classes in the low category, in which the teacher’s role was task simplification. Talat embodied task simplification best when he said “You may be asking what all this gobbledygook means, let me break it apart for you” (observation, September 2006).

Talat maintained a consistent use of Lecture when teaching during all three observations. Fourteen teachers in all maintained one instructional practice across the three years. This represented a significant portion of the teachers, and Guskey (1984) noted that teachers are reluctant to change their teaching practices and typically feel confident in their ability to teach. Talat’s exuded confidence when he worked problems at the front of the room. An interesting connection is that Talat taught in rural schools, the first of which was a high poverty school (74% free or reduced price lunch). This matches with the high amount of lecture observed by McKinney and Frazier (2008) in high poverty schools.

Kanak was classified as moving from *Non-traditional to Traditional*, and only two teachers fell into this category. Kanak went into teaching after a career in the Air Force and as a quality assurance engineer. She was a 50 year old “career changer” (Abell, et al., 2006) that wanted a job that was more family friendly. Her learning-disabled

daughter also provided incentive to become more involved in education. She tried her hand at substitute teaching, and after 3 years as a substitute, she enrolled in an ATCP because she “wanted a job doing things that felt like it was worth doing” (interview, September 2006). Kanak’s previous work reflects the findings of several studies describing how alternatively certified teachers frequently work in educationally related jobs before they enter teaching (Humphrey & Wechsler, 2007; Scribner & Akiba 2009).

Arbaugh, Abell, Lannin, Volkmann, and Boone (2007) found that accelerated, post-baccalaureate interns preferred the models that allowed the internship to be a full academic year with the internship lasting for half a day five days a week. Kanak opted out of this option, instead taking the fast track of summer-only preparation. She later regretted it, stating, “Yeah, about halfway through the year, I thought, ‘Gee, I wish I had interned instead of taught’” (interview, March 2005). This realization of a need for support occurred too late, and the lack of support caught up to Kanak in the following years. However, Kanak’s reasons for changing had nothing to do with student learning, contrary to Guskey’s (1984) findings that teachers make changes in instructional practice when confronted by a positive change in student learning.

Kanak made instructional changes each year, starting with group work permitted many positive benefits in the classroom. Kanak’s case provides evidence that changes in instructional practice, as described by teaching style, do not guarantee that the instructional practices are effective or desirable. Furthermore, Kanak’s location at a private school was not a factor in maintaining effective teaching practices and, in fact, provided little supervision or support for her professional development. Bey (1992) found that teachers received less support than they expected, and in the case of Kanak, her

transition to traditional teaching seems related to the amount of support and expectations required of her. The support and expectations from her certification program were responsible for her choice of lesson during the first observation. In the following two observations, Kanak reverted to traditional teaching. In her third year interview she stated,

We do professional development, but it's a generic thing that meets everyone's needs. Since I'm the only math teacher, there is no math group to go to a math professional development or something. This school has pros and cons, it has advantages other places don't, but it also has disadvantages. (interview, September 2006)

These statements reveal part of the support issues Kanak was dealing with. Based on her observed teaching, it is not clear that the professional development offered met her needs, especially given that she was the only mathematics teacher in the school.

The next two case study teachers embody the “evolutionary” changes in teaching practice as described by Simmons (2005). Of the 25 teachers, Ava and Hannah are the only teachers within their respective categories. Simmons’ (2005) study focused on “highly successful” alternatively certified teachers and she found that they made changes to their instruction over time. Similarly, Ava and Hannah represent two of the best teachers in terms of instructional practices and they made changes similar to those in the Simmons study. Like other high lesson quality classrooms (Arbaugh, Lannin, Jones, and Park-Rogers, 2006), these two teachers allowed for mathematical tools to be used, shared the mathematical authority with the students, and required student explanations. One difference between these two teachers and those of Arbaugh, Lannin, Jones, and Park-

Rogers (2006) high quality lesson teachers is that these two teachers were not involved in district curriculum training. Another difference is that Ava and Hannah were both new teachers.

Furthermore, these teachers were both located in rural areas, where researchers have found that teachers report having less opportunity to work collaboratively with other same-subject area teachers (Chval, Abell, Pareja, Musikul, & Ritzka, 2008). Despite the lack of opportunity, these two teachers made changes from year to year.

Ava represents the case of changing from *Traditional to Non-traditional*. At age 32, Ava spent several years working in the mortgage banking industry where she was able to make use of her degree in mathematics. After having two children she found substitute teaching as a way to get out of the house a few days a week and “was pleasantly surprised that I enjoyed being in the classroom” (interview, May 2005). She was a part time substitute teacher for four years, teaching at all grade levels, from pre-K to 12th grade (Humphrey & Wechsler, 2007; Scribner & Akiba 2009). Ava spoke of learning patience through her life experiences with her own children, with school children, and through teaching Sunday school. These decisions eventually influenced her to change careers (Abell, et al., 2006).

Ava was the only teacher to begin teaching in a traditional style and then transitioned to a non-traditional, i.e. IRE or lecture, format by the third year. However, her first two years were both traditional in style, and although they were different, showed an increase in complexity in classroom interaction. That she ended with a Group Work lesson, where students were responsible for working and producing something of value, is noteworthy. Considering that 14 teachers started with a traditional style, and

were never observed teaching in any other way, makes Ava a good case for the evolution of instructional practice (Simmons, 2005). One final teacher made changes, and these changes were more complex and consistent across the years than Ava's.

Hannah is the case study teacher for *Adjusting an Ever-changing Instructional Style*. By age 40, she had five years working as an economist and 11 years as a homemaker. Before changing careers, she spent several years substitute teaching after her kids were school-aged (Humphrey & Wechsler, 2007; Scribner & Akiba 2009). Her degree in economics allowed her to enroll in an ATCP that would grant a Master of Arts in Teaching degree upon completion.

Hannah stands as the case study teacher who illustrates how changes in instruction can go beyond simply changing formats from year to year, but rather the ability to utilize various strategies within individual lessons. A positive classroom culture was necessary to allow multiple transitions during a lesson, but also Hannah's willingness to design lessons that incorporated multiple instructional strategies. Hannah's continued emphasis on making connections and meaning in mathematics was also a necessary component for incorporating multiple instructional strategies.

Thompson's (1984) study presented two case study teachers relevant to my four teachers. He described a teacher whose instructional practices were informed by constant reflection. Hannah, and to some degree, Ava, are reminiscent of this teacher. His other case was a teacher whose instructional practices were dominated by a desire for classroom control. It seems that one of the two teachers in the *Non-traditional to Traditional* category was primarily concerned with classroom management issues.

I concluded my analysis of changing instructional practices over time with the following assertion:

Assertion 3: Alternatively certified teachers generally choose one instructional style and continued to use it.

I also investigated classroom factors including grade level, course, gender, ethnicity and number of students. Grade level in the *Unchanging* group ranged from 6 to 12, and number of students in a class ranged from 6 to 35. This is similar to the group of teachers making changes, with grade level ranging from 6 to 12 and the number of students in an observed class ranging from 5 to 23. Number of students in a class appears to be a factor in a teacher's choice to change instructional practices.

However, delving deeper into the interviews, some interesting findings surfaced. Two teachers, Kanak and Hannah, were the only mathematics teachers in their buildings. While Kanak had support from her university program during the first year, she employed an engaging lesson using a group work activity. However, after this content-specific support was removed, Kanak's practice changed back to a traditional style of teaching. On the other hand, Hannah found content-specific support through professional development groups at the regional and state level. Furthermore, she participated in a special state program for new teachers. These two cases reveal the effect of support, particularly within the subject area. I conclude with a final assertion:

Assertion 4: Alternatively certified teachers who make changes in instructional practices are of two types:

- *those who move toward a traditional style due to issues of support or classroom management; and*

- *those who expand their instructional repertoire.*

Implications for Practice

The findings of this study, as expressed in assertions 1 and 2, imply that directors of alternative certification programs should evaluate whether or not their courses and requirements provide alternatively certified teachers with a range of instructional practices and examine how to use them effectively in terms of the framework from Figure 1. Furthermore, courses on pedagogy should emphasize the benefit from studying classroom practices through the framework found in Figure 1. In this regard, future teachers can be more reflective of their own practices once they begin teaching.

As expressed in Assertions 3 and 4, the teachers in this study often used one particular style of instruction. Although two teachers in this study used a range of instructional practices, the majority of the teachers did not. Furthermore, the large number of teachers employing lecture as their dominant style was high and those teachers typically did not change from year to year. This implies that efforts should be made by various stakeholders (e.g. principals, district administrators) to identify teachers early in their careers and provide the encouragement and support necessary to expand their instructional repertoire. Targeted instructional support for beginning teachers can help teachers extend their repertoire of instructional methods, allowing them further opportunities to meet the needs of their students.

As seen in this study, most teachers did not display a wide range of instructional practices over the years or within their individual lessons. The teachers who possessed a range of instructional strategies seemed well connected to a group of content-specific people or to content-specific professional development. These findings imply that state-

level policy makers could require that alternatively certified teachers be provided support beyond the required mentor, or a mentor that also teaches the same subject (Scribner & Akiba, 2009). Furthermore, policies should be enacted that require schools that hire alternatively certified teachers to provide two to three years of content-focused professional development. This would assist teachers in schools who have no other content-based support.

The findings of this study suggest that alternative certification programs can have considerable influence on beginning teachers. For a teacher like Kanak, the university courses she was enrolled in provided her with the only content-focused support she received. After her first year, the end of the instructional support by her university program limited her instructional progress. By the end of the study, Kanak had changed from using group work in her first year to individual work and IRE in years two and three, respectively. Furthermore, she regretted the decision to enroll in the fast-track certification rather than the internship model. This implies that program directors of universities offering multiple paths should investigate how their graduates feel after they have been teaching (Abell, et al., 2007). For alternative certification programs, such as Kanak's, there may be a large portion of the group who feel as Kanak did after taking the fast-track.

Program organizers should investigate ways to provide support to graduates that would allow them to stay connected to a group of similar teachers, ideally content-specific groups. Further evidence that this would be helpful was shown in the case of Talat, who created his own network and made efforts to communicate with these other teachers on occasion. Based on this study, Talat did not improve his instructional

repertoire even with this network. In light of this, if university programs were to organize and promote conversations within similar groups, then the teachers, such as Talat, who initially did not see the relevance of theories of teaching and learning could find new meaning as their experience in teaching developed.

Additionally, teachers such as Hannah and Ava exhibited a range of instructional styles. Both teachers found connections with content-based groups; Ava within her school, and Hannah within her region and state. This implies that principals should consider ways to encourage beginning mathematics teachers to be involved in structured, content and pedagogy focused groups that can support the teachers as they grow in the profession.

Suggestions for Future Research

In this study, we saw that some teachers displayed a wider variety of instructional practices than other teachers did. As stated by Hiebert and Grouws (2007), “There is no reason to believe, based on empirical findings or theoretical arguments, that a single method of teaching is the most effective for achieving all types of learning goals” (p. 374). With this in mind, the findings of this study found few teachers who used a variety of instructional practices, such as Ava and Kanak, and even fewer teachers who used a variety of practices within a lesson, such as Hannah did. This raises the question, how can we help teachers develop their instructional repertoire so that they can use the most effective instructional practices for learning the mathematical goals of the lesson?

In terms of the types of instructional practices employed in this study, the Whole Class Discussion format did not appear until the third year observations. This format of teaching is widely advocated for a variety of reasons (Kilpatrick, Swafford, & Findell,

2001; Lampert, 2001; NCTM, 2000; Yackel & Cobb, 1996). What we do not know is if the format of Whole Class Discussion can be implemented effectively earlier in a teacher's career. Additionally, we need to know what supports are needed to make this teaching style available to a larger number of teachers.

Other factors identified were content-specific support. Ava found content supports with the other mathematics teachers in her building. Talat had changed schools and seemed to find more support from teachers outside of his building. However, Ava displayed a range of instructional practices across the three years, while Talat did not. This suggests that a teacher's network of mathematics teachers may have some influence on the instructional strategies a teacher feels comfortable using. Further research is needed to investigate differences in support other mathematics teachers provide.

Another factor was in the support for content-specific professional development. Kanak and Hannah were both the only mathematics teachers in their buildings. However, Kanak reported only receiving support for professional development that was offered in her building for all of the teachers. This meant that she received only general professional development. She wished to be able to go to content-specific events, but was unable due to a lack of support. Hannah, on the other hand, was provided opportunities for content-specific support on many levels. We need further research to show how, if at all, any of these groups and meetings were responsible for her instructional practices. Research is also needed to determine what extent this professional development influenced the way she taught.

Limitations of this Study

This study was limited in that only one lesson was observed each year. No data were collected to determine if a teacher's observed practices were consistent with their day-to-day instructional practices.

Another limitation is that this study only considered teachers who remain in teaching for the first three years. Other teachers within the original data set were excluded because they either: 1) did not teach the first year, or 2) stopped teaching after their first or second year.

Furthermore, teachers studied came from different certification programs and taught in various districts. Classrooms observed from year to year were not always of identical content, nor of student grade level. While a teacher such as Ava was observed always in an algebra 2 classroom, this was not necessarily the case with the other teachers. Also, while the team of researchers made efforts to utilize the same observers with the same teachers from year to year, this was not always possible. However, efforts were made to establish relationships of trust with the teachers, and in that respect, teachers seemed candid and truthful in their presentations of lessons and within their interviews.

Conclusion Highlighting the Significance of this Study

The debate surrounding alternative certification often centers on the quality of instruction (Cicchinelli et al., 2003; Darling-Hammond, 2002; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Walsh, 2001a, 2001b). Quality in general has many interpretations, but if we consider the experiences that teachers provide for students, then classroom observation is necessary (Cooney, 2003; Hiebert et al., 2005; Roth & Garnier,

2007). This study provides observational data for the types of teachers that are in the center of the certification debate. Zeichner and Schulte (2001) analyzed studies that incorporated classroom observation of alternatively certified teachers and concluded, “the evidence about the teaching competence of alternatively certified teachers that is based on classroom observation is very weak” (p. 277). Shen (1998) echoed this saying, “to conduct a valid assessment of differences among the groups in terms of teacher quality, we would have to compare the groups on other quality indicators – particularly pedagogical skills – in future studies” (p. 35). My study is a major step in filling this gap in observational research about what sort of teaching occurs among alternatively certified mathematics teachers who stay in teaching.

For those who state that content knowledge is sufficient for quality teaching (Walsh, 2001a; Walsh & Jacobs, 2007), a consideration of the large number of teachers in this study who employed lecture not just once, but three times, reveals a problem. Even with sufficient work in education and rearing children, the “on the job training” model (Dai, Sindelar, Denslow, Dewey, & Rosenberg, 2007; Sorensen, Young, & Mandzuk, 2005) as experienced by Kanak left her without the support needed to maintain her initial high-quality lesson. Furthermore, Talat was one of six teachers that only employed lecture. In this regard, the “on the job training” had not even produced a traditional teacher after three years for these teachers.

Not all researchers view the debate of teacher certification as a problem of teacher preparation, but rather one of the context the teachers find themselves in once they begin their careers (Ingersoll, 2007). Chval et al. (2008) confirm, in part, Ingersoll’s position by showing that rural teachers report a lack of opportunity for professional development due

to their context. However, the findings from this study suggest that a rural school with only one mathematics teacher does not always prevent participation in developing professionally (i.e., the case study teacher Hannah).

Eight of the 25 teachers employed IRE instructional practices for three years. This is about 33% of the teachers and suggests that, at least among the 25 alternatively certified teachers I studied, IRE may not be the dominant form of “traditional teaching” (Cazden, 1986; Franke, Kazemi, & Battey, 2007). Stigler and Hiebert (1999) found IRE as the prevalent instructional practice within the United States, but my findings provide a closer look at a subset of teachers that may not as closely resemble the population at large. This suggests that alternatively certified teachers may be much different than their traditionally certified counterparts.

Considering the large-scale studies conducted by Weiss, et al. (2003) and Zientek (2007), my study extends their research by providing the qualitative data from a subset of the teaching population. I was purposeful in my selection of only alternatively certified mathematics teachers that remained in teaching for all three years. Furthermore, I followed the teachers over the course of their career, starting with their first year as certified teachers. While the Weiss et al. and Zientek studies provide data on the big picture, my study provides details that heretofore were unavailable.

Arbaugh et al. (2006) conducted a similar study by looking closely within the classroom, making use of some of the data collection instruments that Weiss et al. (2003) developed. Our studies are similar in the number of teachers studied, and we both used the Horizon Observation Protocol as part of our data collection. My study complements part of the Arbaugh et al. study by considering teachers in their first years of teaching,

and looking at their instructional practices. Arbaugh et al. analyzed the lessons of 26 teachers within one district using a particular curriculum while my study analyzed the lessons of 25 teachers across the state of Missouri. My study focused on the type of certification, while the Arbaugh et al. study focused on curriculum-specific professional development.

In these ways, my research relates to the work of other researchers. I have focused my research on alternatively certified teachers, which is relevant to the educational policy community. I purposefully picked teachers who stay in the profession, and followed them as they progressed through the early years of their career. Using a qualitative methodology, I was able to provide data from inside the classroom. My goal is that this study will contribute to the debate of certification, as well as inform people who are involved in the certification of teachers. Furthermore, we now have a better understanding of the instructional practices of our alternatively certified teachers, and how they change over time.

APPENDICES

Appendix A Observed Lesson Field Notes Template

|| Teacher: || School: || Date: || Program: || Class: || Number of students: || Documents:
|| Observer(s): ||

Descriptive information

Design of the lesson

(Triggers to watch for: student learning, sense-making, instruction to promote investigation, student collaboration, technology, resources, assessment, closure)

Implementation/Pedagogy

(Triggers to watch for: teacher confidence, facilitates student collaboration, meaningful content, accommodates diversity, promotes higher order thinking, engages prior knowledge)

Mathematics/Science Content

(Triggers to watch for: appropriate/accurate content, standards-based, interdisciplinary and real-world connections, sense-making, content-specific abstractions, content engages students)

Culture of the classroom

(Triggers to watch for: student participation/engagement, open to diverse ideas, collaborative/collegial relationships between teacher and students, intellectual risk-taking)

Physical environment

(note only that which the teacher can directly influence or control)

Commentary

Appendix B Year 1 Interview Protocol

1. TEACHER APPLICATION OF KNOWLEDGE AND SKILL
 - a. What are the specific skills you have developed through your life and professional experience that help you in your teaching?
 - i. (If applicable) How does your content knowledge gained through past experience help you as a teacher?
 - b. How do your life or professional experiences help you teach students how to apply the content knowledge of the subject you teach?
2. PROGRAM PERSPECTIVES
 - a. Describe how you chose this particular ATCP?
 - b. What were your expectations for this program?
 - c. What aspects of the program have been most helpful to you? Least helpful?
3. CHARACTERISTICS OF THE CLASS THAT WAS OBSERVED
 - a. Course name and subject?
 - b. Grade level?
 - c. Student characteristics:
 - i. How many students are in the class?
 - ii. How many students use a primary language other than English?
 - iii. How many students are on IEPs for a learning disability?
 - iv. How many students have alternative special needs?
 - d. Describe the ability level of students in this class compared to the student population in the school
 - i. Represent the lower range of ability levels
 - ii. Represent the middle range of ability levels
 - iii. Represent the higher range of ability levels
 - iv. Represent a broad range of ability levels
4. CLASS OBSERVATION
 - a. What was the purpose of the lesson and how did it relate to the goals of the larger unit?
 - i. What instruction had this class experienced related to these concepts prior to the session?
 - b. What misconceptions did you anticipate the students would have based on prior lessons/experiences?
 - c. How did you assess understanding for the material covered in the class I observed?
 - i. How did this fit into your assessment plan for the larger unit?
 - d. What role do national/state/local standards play as you plan for class?
 - e. What particular areas of the lesson do you feel were most effective? Why?
 - f. What changes, if any, would you make if you were to teach it again? Why?
 - g. What needs to come next for this class in developing their understanding of the concepts?

Appendix C Year 2 Interview Protocol

1. TEACHER APPLICATION OF KNOWLEDGE AND SKILL
 - a. What aspects of your personal and professional background have been useful to you as a classroom teacher?
 - i. Probe for specifics related to content knowledge, experiences in other organizations, experience working with children, etc.
2. PROGRAM PERSPECTIVES
 - a. Where are you in your preparation program? (e.g., beginning, still taking class, done?)
 - b. What aspects of the program have been most helpful to you? Least helpful?
3. SCHOOL SUPPORT
 - a. If you were teaching last year, are you still at the same school?
 - i. If not, what were the reasons for the change?
 - b. Describe some of the issues that pose the greatest challenge to you as a classroom teacher.
 - c. When you have a question related to your teaching practice what resources do you turn to?
 - i. To what extent are the following people helpful: Mentor teacher, other teachers, principal, other?
4. CLASS OBSERVATION
 - a. What was the purpose of the lesson and how did it relate to the goals of the larger unit?
 - i. What instruction had this class experienced related to these concepts prior to the session?
 - b. What problems understanding the material did you expect your students to have?
 - i. Where did your ideas about these potential misunderstanding come from? (e.g., experience, your preparation program, mentor teacher, other teachers, etc.)
 - c. How did you assess understanding for the material covered in the class I observed?
 - i. How did this fit into your assessment plan for the larger unit?
 - d. What particular areas of the lesson do you feel were most effective? Why?
 - i. What changes, if any, would you make if you were to teach it again? Why?
 - ii. What needs to come next for this class in developing their understanding of the concepts?

Appendix D Year 3 Interview Protocol

1. Career Choices and ATCP perspectives
 - a. Think back to when you started this career change. What made you decide to be a teacher?
 - i. In what ways are you satisfied or dissatisfied with your decision to become a teacher? (triggers: e.g., job satisfaction, salary, preparedness, work conditions?)
 - b. How long do you plan to stay in teaching? What factors have influenced your decision to stay or leave teaching (e.g., family considerations, salary, work climate, etc.)?
 - c. Do you foresee yourself staying in public education but moving into a non-teaching position (e.g., assistant principal, principal, technology/media specialist, etc.)?
 - i. If so, what factors would influence that decision?
 - d. What aspects of your professional work experience *prior to teaching* have been most useful to you as a classroom teacher?
 - i. In what ways? (Probe on content knowledge, experiences in other organizations, experience working with children, experience in activities related to teaching and learning, etc.)
 - e. What aspects of your general life experience prior to teaching have been most useful to you as a classroom teacher?
 - i. In what ways?
2. Alternative Certification Program Perspectives
 - a. Think back over your preparation experience. Now that you have some experience teaching, tell me your thoughts about the quality of your preparation experiences.
 - b. What types of knowledge and/or skills did your preparation program offer you that have helped you MOST in your teaching? Please explain and provide examples.
 - c. What types of knowledge and/or skills did your preparation program offer you that have helped you LEAST in your teaching? Please explain and provide examples.
3. School Support
 - a. To what extent are you satisfied or dissatisfied with your situation in this school? Describe the factors that contribute to your satisfaction or dissatisfaction?
 - b. How many years have you been at this school? What are the chances you will return to this school next year? Why?
 - c. To what extent (and in what ways) are you able to apply what you learned in your preparation program in your classroom instruction?
 - i. What is it about this school that facilitates (or impedes) the application of that knowledge or those skills?
 - d. How supported do you feel at this school to be an effective teacher?
 - e. To what extent does that support come from (Please describe):
 - i. Teachers in general
 - ii. Teachers in the same subject area
 - iii. Your mentor teacher
 - iv. Administrators
 - f. Do you receive the kind of support you need when you seek it?
4. CLASS OBSERVATION

- a. What was the purpose of the lesson and how did it relate to the goals of the larger unit?
- b. What instruction had this class experienced related to these concepts prior to the session?
- c. What problems understanding the material did you expect your students to have?
- d. Where did your ideas about these potential misunderstanding come from? (e.g., experience, your preparation program, mentor teacher, other teachers, etc.)
- e. How did you assess understanding for the material covered in the class I observed?
 - i. How did this fit into your assessment plan for the larger unit?
- f. What particular areas of the lesson do you feel were most effective? Why?
- g. What changes, if any, would you make if you were to teach it again? Why?
- h. What needs to come next for this class in developing their understanding of the concepts?

Appendix E Classroom Observation Synthesis Protocol

TEACHER CLASSROOM OBSERVATION SYNTHESIS

To be filled out by the observer(s) of the teacher's class as soon as possible after the observation.

I. BACKGROUND	
Teacher Name:	
Date:	
Observer(s):	
ATCP:	
District:	
School:	
Grade level(s) in class:	
Course title:	
Subject Observed:	
<input type="checkbox"/> Mathematics <input type="checkbox"/> Science <input type="checkbox"/> Both	
Duration of Observation: Time start: _____ Time end: _____	
Teacher gender:	Age: _____
<input type="checkbox"/> Male <input type="checkbox"/> Female	
Teacher ethnicity:	
<input type="checkbox"/> American Indian or Alaskan Native <input type="checkbox"/> Asian <input type="checkbox"/> Hispanic or Latino <input type="checkbox"/> Black or African-American <input type="checkbox"/> Native Hawaiian or Other Pacific Islander <input type="checkbox"/> White <input type="checkbox"/> Other	
Students' gender:	
Number of males _____	
Number of females _____	
Students' ethnicity (indicate if present in the class):	
<input type="checkbox"/> American Indian or Alaskan Native <input type="checkbox"/> Asian <input type="checkbox"/> Hispanic or Latino <input type="checkbox"/> Black or African-American <input type="checkbox"/> Native Hawaiian or Other Pacific Islander <input type="checkbox"/> White <input type="checkbox"/> Other	

Score

Yes = There is documented evidence supporting the indicator.

No = There is no documented evidence supporting the indicator.

N/A = “Not Applicable” The indicator inappropriate given the purpose and context of the lesson.

DK = “Don’t Know” There is not enough evidence for you to make a judgment. There is insufficient Information

II. DESIGN OF LESSON				
	Yes	No	N/A	DK
1. Reflects an understanding of learning as an active process.				
2. Helps students understand the purpose of the lesson and where it fits into the larger picture.				
3. Encourages a collaborative approach to learning.				
4. Includes use of technological resources for meaningful learning.				
5. Provides adequate time and structure for “sense-making,” including reflection about concepts, strategies, issues, etc.				
6. Provides adequate time and structure for wrap-up.				
7. Incorporates instructional strategies reflecting attention to participants’ experience, preparedness, and/or learning styles.				
8. Utilizes resources which support instruction.				
9. Incorporates instructional strategies and activities reflecting attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials).				
10. Includes formal assessments of students consistent with investigative math/science.				
Synthesis Rating of Lesson Design (Circle one)				
1	2	3	4	5
Not at all reflective of best practice in math/science education				Extremely reflective of best practice in math/science education

III. IMPLEMENTATION/PEDAGOGY		Yes	No	N/A	DK
1. The teacher uses questioning strategies that enhance the development of conceptual understanding (i.e. required explanation and prediction).					
2. The teacher appears confident in his/her ability to teach mathematics/science.					
3. The teacher effectively provides students with opportunities to build on their present understanding as they create new understanding.					
4. The teacher encourages a collaborative approach to learning and supportive interactions.					
5. The teacher relates the content to students' daily lives and interests and to a larger framework of human endeavor and understanding.					
6. The pace of the lesson is appropriate for the developmental levels/needs of the students and the purpose(s) of the lesson.					
7. The instructional strategies are consistent with investigative mathematics/science.					
8. The teacher's classroom management style/strategies enhance the quality of the lesson.					
9. The teacher adjusts instruction according to students' levels of understanding.					
10. The teacher's questioning strategies are likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time," identified prior conceptions and misconceptions).					
11. The lesson was modified as needed based on teacher questioning or other student assessment.					
12. Instructional strategies are consistent with the stated purpose(s) of the unit.					
13. The instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, and/or learning styles.					
14. The instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials).					
Synthesis Rating of Implementation/Pedagogy (Circle one)					
1	2	3	4	5	
Not at all reflective of best practice in math/science education					Extremely reflective of best practice in math/science education

IV. MATHEMATICS/ SCIENCE CONTENT		Yes	No	N/A	DK
1. Mathematics/science content is appropriate for the purposes of the lesson and the backgrounds of the students.					
2. Mathematics/science content is standards-based.					
3. Students are intellectually engaged with important ideas relevant to the focus of the lesson.					
4. Teacher displays an understanding of mathematics/science concepts, (e.g., in his/her dialogue with students).					
5. Appropriate connections are made to other areas of mathematics/science, to other disciplines, and/or to real-world contexts.					
6. Extent of “sense-making” of mathematics/science content within the lesson is appropriate for the purpose(s) of the lesson and the needs of the students.					
7. Adequate time and structure are provided for “sense-making,” including reflection about concepts, strategies, issues, etc.					
8. The mathematics/science content is appropriate for the developmental levels of the students in this class.					
9. The teacher provides accurate content information.					
10. Mathematics/science is portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation analysis, and/or proof/justification.					
11. Elements of mathematical/science abstraction (e.g., symbolic representations, theory building) are included when it is important to do so.					
12. The problem, question, representation (or other identified purpose) presented to students is comprehended by and is interesting to students.					
Synthesis Rating of Mathematics/Science Content (Circle one)					
1	2	3	4	5	
Not at all reflective of current standards for math/science education				Extremely reflective of current standards for math/science education	

V. CULTURE OF THE CLASSROOM				Yes	No	N/A	DK
1. Active student participation/engagement is encouraged and valued.							
2. There is a supportive climate of respect, for students' ideas, questions and contributions.							
3. Interactions reflect collaborative/collegial working relationships among students (e.g., students work together, talked with each other about the lesson).							
4. Interactions reflect collaborative working relationships between teacher and students.							
5. The classroom climate encourages students to generate ideas, questions, conjectures, and propositions.							
6. Students demonstrate a willingness to share ideas and take intellectual risks.							
7. Intellectual rigor, constructive criticism, and the challenging of ideas are evident.							
8. Student report, express, clarify and justify their ideas.							
Synthesis Rating of Culture of the Classroom (Circle one)							
1	2	3	4	5			
Classroom culture did not facilitate student learning				Classroom culture facilitated student learning			

VI. SUMMATIVE RATING OF THE OVERALL QUALITY OF THE ENTIRE LESSON
<input type="radio"/> Level 1: Ineffective Instruction (Select one below.) <ul style="list-style-type: none"> <input type="radio"/> Passive "Learning" <input type="radio"/> Activity for Activity's Sake
<input type="radio"/> Level 2: Elements of Effective Instruction
<input type="radio"/> Level 3: Beginning Stages of Effective Instruction (Select one below.) <ul style="list-style-type: none"> <input type="radio"/> Low 3 <input type="radio"/> Solid 3 <input type="radio"/> High 3
<input type="radio"/> Level 4: Accomplished, Effective Instruction
<input type="radio"/> Level 5: Exemplary Instruction

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